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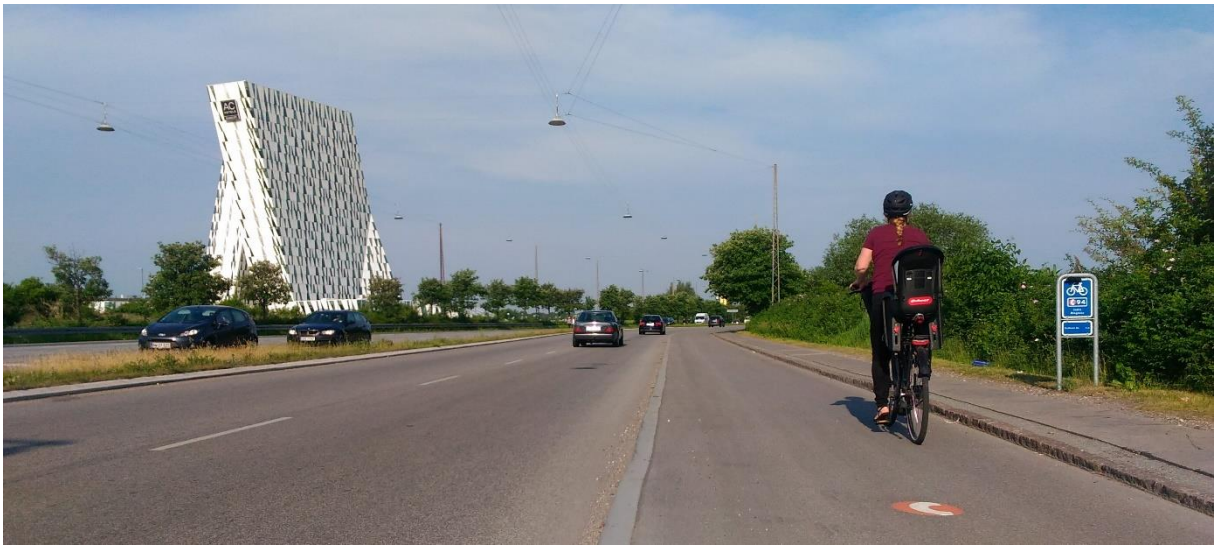
MASTER THESIS

Making cycle superhighways a sound investment for a sustainable future:

the decision-making tools and process.



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PREFACE

After my experience as an Intern at the Ministry of Transport of the municipality of Buenos Aires, Argentina, during the previous semester of this Master's program, I wanted to discover another perspective of transport planning and especially the process of how to make a project convincing in the eyes of the city council members. Cooperating with Copenhagenize Design Co, leading international consultancy based in Copenhagen, Montréal and Brussels, was a way for me to learn how such influential mobility experts, passionate about making cities around the world more bicycle-friendly, can construct a good argument in favour of bicycle infrastructures and policies and defend their vision.

Due to the growing interest of French metropolis governments towards cycle superhighways and the Danish knowledge shared across the world through the team of Copenhagenize Design Co about this topic, I made the decision to investigate the implementation of this specific type of infrastructures in France.

My previous experience within a public entity had shown me how the economic competitivity of a transport project is crucial to defend it to public decision-makers and the various stakeholders involved in the project. This project aims to investigate the use of cost-benefit analysis in cycle superhighways projects using an actor-network perspective to define if such tool can contribute to making cycle highways more popular.

ABSTRACT

Based on the latest knowledge available on the use of CBA in cycling infrastructures projects in Denmark and the Netherlands, the following analysis gathers information and aims to apply them to the decision-making process of cycle superhighways in France. After a detailed explanation of the context of mobility matters in France, two case-studies are presented so as to collect opinions on the process of implementing the above-mentioned infrastructure and analyse how to engage in a process of convincing and mobilizing the many stakeholders of the metropolises of Toulouse and Lyon, France. This project is grounded in academic literature about CBA, rational argumentation and empirical data about the positive aspects of cycle superhighways and confronts the political mechanisms in a rapidly changing context.

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LIST OF ABBREVIATIONS

ANT - Actor-Network Theory

CBA - Cost-Benefit Analysis

CS - Cycle Superhighway(s)

ECF - European Cyclists' Federation

FUB - French Cyclists' Federation

IRR - Internal Rate of Return

NPV - Net Present Value

OECD - Organisation for Economic Co-operation and Development

SCS - Secretariat for Cycle Superhighways

TMT - Transport Modelling tools

UPA - Urban Planning Agency

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1. INTRODUCTION

In this master thesis project, I seek to investigate the decision-making processes allowing the implementation on cycling infrastructures in France and contribute to make the use of an improved decision-making support tool more inclusive in with the aim to develop sustainable cities.

In second 2, I will demonstrate how this project contributes to the Master's program entitled Sustainable Cities MSc. Then, I provide the reader with the context of this analysis and explain the motivations of the cooperation with Copenhagenize Design Co. Finally, I will argue about the potential of cycle superhighways in French metropolises based on my background knowledge on various contexts, including the Capital Region of Copenhagen and Flanders, Belgium, along with an extensive literature research.

In section 3, the theorical and methodological frameworks will be presented, and I will introduce and define cost-benefit analysis (CBA), the cornerstone of this project, and show the limitations of this decision-making support tool. By using Callon and Muniesa's approach of the economic markets, I will then define the process of calculation and relate it to the process of CBA. To better understand the mechanisms, interconnections and relationships between the many actors presented in section 4, I will end section 3 by introducing the actor-network theory (ANT).

After a description of the complex organisation of the bicycle urbanism world on a nation level in France, I will turn to two delimitated cases in section 4. Using ANT, I will define and explain the visions, challenges and knowledge and relationships of the actors involved in the CS project network of two selected cities, namely Toulouse and Lyon, which will provide different examples of governance and potential.

Based on the latest available information of both cost-benefit analysis and cycle superhighways, I will seek to provide recommendations in favour of the implementation of this type of infrastructures in the two above-mentioned metropolises.

2. CONTEXT

2.1Contribution to Sustainable Cities MSc

Sustainable city is a term largely used by professionals of various disciplines. It refers to the creation, the evolution, or the remodelling of today's cities into an environment able to sustain in the future, where the various fields of activities making an actual *city* converge and act together for the common good. The definition of a city might also be reinvented, as the separation between urban, suburban and rural areas might change, being more subtle and adaptable, depending on how the resources and services produced in or imported to each of these areas are managed in the future. The cities' shapes and transport corridors might also evolve in ways that will blur today's definition of a city, where many of them are surrounded by a ring road, crossed by a river or built around their religious centre (medieval towns built around a church for instance) or their commercial district (such as a harbour for coastal cities).

In today's time, urban planners, in cooperation with scientists, decision-makers and the civil society, have the duty to create a bearable, enjoyable and resilient environment urgently. For decades, environmentalists and researchers have warned the international community about the upcoming resources shortage and population migrations due to the consequences of a warmer climate such as water level rising, droughts, conflictual environments and the consequences of the industrialized world on our cities such as the emissions due to agriculture and transport of goods and people, densification of urban zones and the induced increased need of resources (Servigne & Stevens, 2015). The discipline focusing on those potential scenarios is named "collapsology" and was named by French Agronomist Servigne and his fellow researcher Stevens. Even though the conclusions of their work on the near future are fascinating and alarming, this complex discipline falls out of the scope of this project. However, it will be important to keep in mind that each and every urban systems of the world (and therefore of our cities) and intertwined, interconnected, and that each step towards the most 'sustainable' version of our respective disciplines (be them agriculture, transportation, governance, commerce, etc) are crucial. The metaphor often used by "collapsologists" is usually the collaborative work of hummingbirds (Rabhi, 2018). Our work as sustainable urban planners is to interact, exchange knowledge and experience, and co-create an environment for all.

Sustainable transport options refers to modes of transport not harming the environment, or with a negligible level of emissions (mainly produced during the vehicle's construction phase or waste disposal). Even though the definition of sustainable transport options remains blurry, this category seems to include various vehicles, be them motorised or not. Indeed, an electric vehicle (EV) is considered by many people as a sustainable option, since it neither generates any exhaust fumes nor burns oil. However, a variety of city planners and particularly transport planners would argue that because of their need of mineral resources to make the required electric batteries (which involves fossil fuelled machinery and intracontinental transport), EVs are far from being sustainable vehicles. From an urban planning perspective, where 'sustainable' would refer to a durable planning, the problem remains the car in itself, not its motorization (Sadik-Khan & Solomonow, 2017). Tackling the issues created by decades of car-centric planning[1] therefore involves reducing to a minimum the number of cars in our cities, to leave room for other (truly) sustainable modes of transport.

The present analysis focuses on the bicycle as a mode of transportation and the required infrastructures to provide city dwellers and inhabitants of suburban areas with a qualitative daily transportation option. Durable, human-powered and fossil fuel-free, the bicycle is therefore a resilient mode of transport. The resilience aspect is of utmost importance when addressing the many disciplines of sustainable city planning. Danish city planning has integrated this aspect for a long time. Indeed, due to the heavy rains that Denmark suffered in 2011, the city planning projects which followed incorporated the resilience aspect as a priority, and in particular the capacity of soils to absorb water. The state therefore relies on infrastructures resilient to climate change as well as resilient modes of transport, such as the bicycle (C. Imbert, personal communication, November 21, 2019).

[1] term used in Colville-Andersen, M. (2018). Copenhagenize: the definitive guide to global bicycle urbanism. Island Press.

Figure 1 - Copenhagen's Enghaveparken, Climate Park - Source: Tredje Natur

Another critical aspect of sustainable city planning is public health. Transportation is one of the fundamental interconnected systems of any city and therefore impacts the whole of population. Commuting should be healthy and not harmful for neither commuters nor the environment. Emission-free, quiet, and with a minimal space-requirement, the bicycle is a tool to reshape our cities and provide all city dwellers with a healthier environment and transport option.

Finally, from an economic perspective, governments in favour of a widespread bicycle-friendly strategy have understood the benefits of having an active population, consequently healthier and more productive. Some of these benefits will be detailed later in this report.

This analysis does not aim to demonstrate unknown benefits of cycling for citizens but rather targets the methodological framework of public investment toward cycling infrastructures. In this master thesis project, I seek to contribute to make the use of a decision-making support tool more frequent, inclusive of the many positive aspects of cycling for society, and suitable for the social, economic and environmental challenges that France, among many countries across the world, is faced with. I will focus on the instrument that is CBA and then I will reflect on the perspectivation.

Based on the latest information available regarding the development of cycle highways in France, this analysis will investigate the following aspects:

- The use of cost-benefit analysis in the study of cycling infrastructures in France
- The distribution of 'active mobility budgets' and their use by public entities

- The relationships between the different actors of cycling infrastructure planning from an actor-network perspective (influence, power, responsibility, knowledge.)
- The limitations to overcome to make cycle highways attractive infrastructures (for both decision-makers and potential users)

2.2 Contextualization & Research Question

Over the 20th century across the world, transport planners and city architects have focused for decades on improving the capacity of roads and streets for motorized vehicles in both urban contexts and intra-urban zones. Former NYC Transport Commissioner Janette Sadik-Khan describes this tendency in the US where mega-projects such as bridges, bypasses, new highways flyovers and interchanges were designed and built to accommodate the rising number of motorised vehicles driving to and from large cities (Sadik-Khan & Solomonow, 2017). This type of transport planning was as a standard practice in 'car-oriented cities', also referred to as 'Stage 1 cities' by the CREATE project[2]:

"Rapid urban economic growth leads to a fast increase in car ownership and use, and general support for policies to cater for this growth (e.g. by new road building, providing extra car parking spaces). This is often linked to strict land use zoning policies that spatially segregate activities and discourage mixed-use development; and street designs which discourage walking and cycling and may reduce footway width to increase carriageway provision. Investment in public transport may decline, and more of the street space in general is allocated to cars and general traffic." (Jones & Anciaes, 2018, p. 7)

Such designs have had disastrous consequences on, among others, congestion intensity and frequency in many large cities across the globe. Firstly, congested highways reduce the liveability of neighbouring residential zones (visual aspects, air quality, noise pollution[3], safety issue) making them unattractive. Traffic jams have also changed our perception of travel times and distances. Each city faces traffic problems in specific corridors (be them highways, city rings or local streets). These congested corridors are usually known, and nowadays traffic jams are predictable thanks to the electronic devices available to both users and transport monitoring agencies (Jones & Anciaes, 2018), but still many commuters ride their personal vehicles to get

[2] project funded by the European Commission
[3] Gössling et al., 2019

to their destination, either as they have no other options available or by choice. Air Pollution Expert Olivier Blond exemplifies the time loss experienced by motorists in Paris area: a driver stuck twelve minutes per day in a traffic jam loses on average forty-five hours a year. This is the equivalent of a spending a week, motionless, behind a wheel drive. This week could be spent in a better way (Blond, 2018). This time spent in traffic jams also has social and professional impacts: this time window is neither spent on the workplace nor with families or loved ones. Finally, fossil fuelled vehicles harm the environment due to the resources they require, the transport of the required resources and their emissions that contribute to global warming.

Additionally, another phenomenon has amplified the congestion rates on the French roads network. Often labelled as transport poverty (Martens, 2013), this term refers to the lack of transport options for some population groups. As a direct consequence of radical political decisions prioritizing the most used train lines and highways over local train lines and public transport (PT), many residents of suburban zones have no other options but to invest in a car and drive it daily through the traffic jams to get to their respective workplace. This induced traffic causes congestion since PT users shift to the personal car as a mode of transport.

Secondly, from a technical perspective, the crucial problem to address is now the space used by personal (motorised) vehicles compared to their load factor (passengers and/or goods), and their time/space requirement (ratio between travel speed and vehicle's surface): one car stuck in traffic uses approximately 20 m² for several minutes (see figure 2). This surface is, in a way, privatised by this car. In city centres, car parking provision has long been an issue, especially in our rapidly densifying cities where the space available to city dwellers will need to be managed in an optimal way so as to fit more people and allow them to commute in a safe, enjoyable and efficient way.

Based on the abovementioned experiences and consequences, today's transport planners must change the question about transport in our cities: ask how many *people* we can move down a street instead of how many *cars*? (Colville-Andersen, 2018 p.199). Using the bicycle as the unique transport mode on selected heavy-used corridors can tackle the road capacity issues in our rapidly-growing cities and densifying urban zones due to its minimal need for space and emission rate, and its optimal ratio between passenger capacity, use of the space and travel

speed. A moving bicycle needs 5 m² whereas a moving car requires 140 m² for a travel speed of 50 km/h (see figure 2).

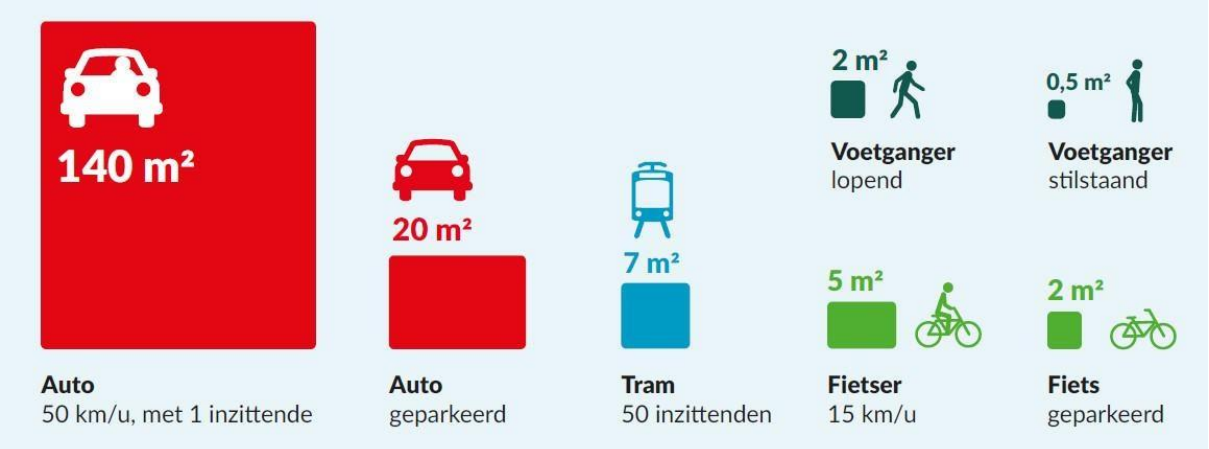

Figure 2 - Use of space of different means of transport - Source: fietscommunity.nl

A sustainable city should be free of congestion and provide commuters with a healthy, convenient and reliable transport solution. Study shows in Strasbourg, the most bike-friendly city in France (C. Imbert, personal communication, November 21, 2019), efforts should be made to provide the suburban area with better cycling infrastructures to increase the modal share of these areas and therefore reach the ambitions of the metropole which is to reach a 16% modal share of bicycles by 2030 (City of Strasbourg, 2019). This analysis emphasizes on a specific type of bicycle infrastructure along with the process of making its implementation convincing in the eyes of decision-makers from public entities.

For such a visionary project to be implemented in France, cycling must be considered as a veritable transport mode (and not only as a leisure activity) and be considered as such in traffic models and decision-making support tools such as cost-benefit analyses. To do so, it is necessary to challenge the established tools and methods that constitute the current transport paradigm.

"In order to evaluate cycling on equal terms with other modes of transport and to improve the foundation for prioritization of resources for transportation, it is necessary to establish a methodological basis as well as unit prices for cycle transport." (Willumsen & Roehl, 2010, p. 1)

2.2.1 Context of the following analysis

For more than 10 years, Copenhagenize Design Co. has been helping to make cycling a means of transport in many countries around the world. The firm's objective is to inspire and advise city governments to re-establish cycling in their territory. Copenhagenize consists of a headquarters based in Copenhagen, Denmark, and two local offices based in Montreal, Canada, and Brussels, Belgium. Their team is multidisciplinary and passionate, bringing together experts in mobility, urban planning, communication, graphics and wayfinding. They work hard to turn cities into livelier places. They believe in the interest of building territories that are human-scaled and they are convinced that cycling and walking are effective means of transport to design more humane territories. They do no called themselves "cyclists", because of the sporty connotation, but prefer "bicycle riders". Throughout their work, they demonstrate that increasing the number of bicycle riders is an effective way to improve the quality of life for citizens. That's why they specialize in cycling as a mode of transportation and work on topics ranging from planning, communication and design of cycling infrastructure. They also conduct master classes and conferences to convey their passion and their vision of the city. They approach all their projects from the user's point of view, and they use design, sociology and common sense as starting points for their thinking. They first think about cyclists and pedestrians and they design the project from there.

The analysis hereby proposed aims to address the assessment of an innovative type of cycling infrastructures across French metropolises by analysing the decision-making process within public entities. It will focus on cost-benefit analysis (CBA) as a decision-making support tool due to the author's background knowledge on this tool, mainly acquired through past partnerships with public stakeholders and dedicated modules during the first year of the MSc program. Therefore, the research question of the present report is the following:

2.2.2 Research question

Making cycle superhighways a sound investment for a sustainable future: the decision-making tools and process.

How can an improved support tool for decision-making promote the development of cycle superhighways in France?

2.3 Potential of Cycle Superhighways

2.3.1 Context

Throughout the past few years, recreational long-distance cycling itineraries (often referred to as 'green routes') have become increasingly popular in France with the development of national and European routes[4] connecting countries and consequently metropolises to each other's. This type of cycling infrastructures has a recreational purpose[5], unlike CS which serve as daily transport corridors. The former is widespread on the European level whereas the latter is implemented on the metropolitan level. These types of long-distance cycling routes must be distinguished, however in some rare cases, a CS network might use a segment of an existing green route if the standard is acceptable and the itinerary optimal (City of Strasbourg, 2019). However, both infrastructures are becoming attractive to public entities. From a local perspective, many municipalities within these metropolises have shown their interest in increasing their cycling modal share by enlarging their cycling infrastructures network, improving it or using the opportunity of a neighbour expansion to design a completely new infrastructure.

Nielsen & Skov-Petersen (2018) have defined three scales of the analysis of bikeability as a decision-making factor for cycling (local, around home or workplace, urban (up to 4 km) and regional (up to 40 km). All three factors need to be considered to adequately assess the possibilities for promoting cycling in any of these areas. In the present context and according to the authors' definitions, the regional scale - i.e. the metropolitan scale in France - is where efforts should be made to improve the conditions for CS and consequently enhance the bikeability of the area.

2.3.2 Metropolises

Metropolises are therefore politically and physically situated at the encounter between the national/European top-down implementation of long-distance itineraries and the bottom-up dynamic of local politics in favour of the development of cycling as a mode of transportation.

[4] such as the Eurovelo network: https://en.eurovelo.com/about-us

[5] Green routes have been implemented in France on a large scale due to the profusion of towpaths which were converted into green routes by laying asphalt and implementing wayfinding signs.

The French metropolis model is particularly adequate in terms of governance scale to study, implement and manage cycle superhighways. Indeed, unlike the governance model of the Capital Region of Denmark where the CS Secretariat had to convince step-by-step the 27 municipalities now involved in the CS network - only 15 were involved in 2009 when the CS project started - (Sekretariatet for Supercykelstier, 2019), the French metropolis governments are the transport authorities is charge of their territory. Consequently, if the decision to implement a CS network was made on the metropolis level on governance, the process of involving actors - labelled as the four moments of translation by Callon (1986) - could be simplified as the actors would not need to be approached then convinced, they already are actors of a same network.

2.3.3 Target group

- Commuters

As explained above, unlike European itineraries meant to enhance bicycle tourism, CS have a very different purpose. Indeed, their objective is to provide commuters with a fast, reliable and attractive option to commute from home to the workplace and back. Cycle superhighways are by definition direct and comfortable enough to please experienced commuter cyclists and make this mode of transportation attractive to the people who might hesitate between various modes. Their path is not necessarily scenic but rather direct, crossing strategic locations to 'catch' large number of potential bicycle users.

- Logistics

Due to the directness and coherent standard of CS, one could imagine that in the near future, with the growing interest of cities for bicycle logistics, cargo-bikes carrying heavy loads could be in need of such an infrastructure, just like lorries travel from metropolises to metropolises on state highways.

2.3.4 Distribution of active mobility budgets

The budget allocated by the Ministry of Transport for active modes (namely walking and cycling) is immeasurably low compared to the budget provided by some of the largest French metropolises exclusively for the promotion of cycling across their respective territories. For instance, the metropolis of Bordeaux has announced in its Bicycle Plan an upcoming allocation of 70 M€ over 4 years for the promotion of cycling (Bordeaux Metropole, 2019). Also, the

metropolis of Lyon has announced in its Bicycle Plan a budget of 160 M€ over 4 years (Lyon Metropole, 2016). The distribution of active mobility budgets across France and between metropolises is therefore unbalanced which results in incomparable achievements.

Some metropolises, such as Lyon and Toulouse, are currently studying the feasibility of CS itineraries (S. Boux de Casson, personal communication, October 16, 2019) & (H. Bécart, personal communication, December 12, 2019), whereas the metropolises where decision-makers have launched bicycle-friendly strategies for long, such as Strasbourg and Grenoble, already own extensive networks of CS.

The recently announced "Bicycle and Active Mobility Plan" is meant to provide alignment in terms of bikeability across the country, reflecting the voluntarism of the current government to re-establish the bicycle as a mode of transport. However, the official bill does not indicate what share of the budget is to be dedicated to cycling infrastructure and what share to walking infrastructure. The results of the interviews conducted, along with an extensive research into the latest information available on the abovementioned plan have failed to provide any information about the repartition of these funds. From a top-down perspective, the national government has not announced yet how these funds will be allocated and has only mentioned that a call for projects will be launched. Metropolises, municipalities and any other local governments in favour of cycling will therefore need to apply to these funds. However, the decision-making process vis-a-vis the evaluation of the worthy projects submitted remains blurry.

Also, as found through the interviews conducted, some metropolises do not use any decision-making support tool. The cost estimations of CS are therefore made "roughly" (S. Boux de Casson, personal communication, October 16, 2019) until the project is accepted by decision-makers. Only then can the authorities responsible for the project define precisely the costs of the whole infrastructure. This methodology shows mainly two weaknesses in the current cycling infrastructures planning paradigm: 1) CS are not precisely estimated, which might result in unwanted projects extensions, users insatisfaction leading to conflicts with elected leaders and consequently affect the credibility of the CS project. 2) Cycling infrastructures are estimated only on the basis of the construction cost, which includes raw materials, workforce, urban furniture and maintenance. The lack of decision-making support tool such as CBA on the

metropolis level of governance prevents the urban planners that work with CS to identify and calculate the real (social and environmental) costs and benefits of the planned infrastructure.

3. THEOREDICAL & METHODOLOGICAL FRAMEWORK

3.1 Definition and objectives of CBA

A cost-benefit analysis mainly serves as a support tool for decision making and can be defined as an *"analytical tool for judging the economic advantages or disadvantages of an investment decision"* (Sartori et al., p. 25). According to Damart & Roy (2009), *"CBA is a technique for evaluating public spending, which aims to avoid inappropriate distribution of public resources"* (p. 201). It involves elaborating on important information as well as social and economic consequences of the project plan. *"In principle CBA is equally applicable to private and public projects, but because of its focus on social welfare (instead of, e.g., profits) the method is most frequently used for public decision-making. CBA could be used in the appraisal of all kinds of public projects, e.g. building a new school, or hospital, but in practice it is more often used in the transport sector than in other sectors"* (TABLE, R., 2011, p. 5).

The complexity of the social and environmental benefits of cycle superhighways as described above, illustrate the need for such a comprehensive analysis. A cost-benefit analysis allocates a monetary value to all the defined positive effects (benefits) and negative effects (costs) of the intervention. Later, the values are discounted in order to calculate a net total result in the form of either a net present value (NPV) or an internal rate of return (IRR), both expressed in monetary terms. These performance indicators allow comparability between project alternatives (EC, 2014). However, the results of CBA do not indicate how the various costs and benefits identified are *"distributed over different population groups"*. (Martens, 2011, p. 960)

Using CBA to assess the profitability of a cycle superhighways network has various advantages. To begin with, this tool presents a holistic approach which takes both positive and negative effects into account. Using all social-economic impacts allows to compare and weight different heterogeneous aspects against each other. CBA does not only allow for calculation but also for identification of the various impacts of each specific project, and each options of a same project. Indeed, some of either costs or benefits of an alternative option (in the present case the CS) might be unknown by decision-makers and the many of the actors involved in the project. Therefore, investigating all the interconnections with other systems of a city is crucial if the approach is to be truly holistic and sustainable.

However, some costs and benefits relevant for a specific project might not have a market price. In the case of a CS networks, various non-market values have to be estimated. Techniques such as generic pricing or willingness to pay have strengths and weaknesses that need to be considered. *"The choice to work with willingness-to-pay reflects the welfare economic fundamentals of the method: what matters in the end are consumer benefits."* (TABLE, R., 2011, p. 5) The estimation of each factor is therefore a crucial step as it can largely influence the outcome of the analysis. The estimation is also fundamental in the process of involving the civil society as transportation projects such as cycle superhighways require public resources which are gathered through public taxes. The wide range of effects of which some might be difficult to estimate can lead to the analysis becoming excessively long and consequently costly (H. Treasury, 2018). A further point that needs to be taken into consideration are externalities of the project caused by a third party.

CBA is to be used as an ex-ante decision-making support tool to compare and weight the consequences (be them positive or negative) or each proposed option. *"It aims to evaluate the set of direct and indirect effects of a project, its financial and non-financial effects on the set of economic agents concerned with the investment."* (Damart & Roy, 2009, p. 201) In the process of sorting the negative effects (costs) taken into account in CBA, they will be classified in two categories, namely internal costs and external costs. Willumsen and Roehl (2010) provide a definition of these categories of costs when analysing a cycling infrastructure project: *"The internal costs are the only costs, which the cyclist (in theory) responds to when deciding transport mode and route (the costs are internalized in the cyclist's choice function). The external costs are the costs for third party caused by the cyclist's choices and behaviour that do not (in theory) affect the cyclist's choices."* (p. 4)

3.2 Limitations of the current CBA

The previous sub-chapter was aimed to demonstrate the potential of CBA as a decision-making support tool when assessing the viability of CS networks. This chapter will summarize the frequent criticism made of the cost-benefit analysis in order to reflect on the two cases described later and lead to a discussion. Critics are often based on two aspects of CBA, the overall process of CBA and the exclusion of the social aspects.

3.2.1 Social aspects

One of the popular benefits of implementing a new competitive transportation option or improving an existing one is the reduction of the travel time, and especially the commute between the place of residence and the workplace. According to the OECD and the International Transport Forum, the improvements in travel times will induce better accessibility:
"CBA focuses on direct user benefits because they are a good approximation to total benefits and easier to measure than ultimate benefits, not because of any decision to narrow down the analysis. [...] The direct impact of a project, e.g. time savings, will translate into improved accessibility for various activities (work, school, leisure, shops, etc.) and into increased economic activity." (TABLE, R., 2011, p. 12)

Due to the intentional sprawl of CS networks which are theoretically designed to be accessible to as many citizens as possible, it is relevant to wonder if the travel-time-savings criterion serves the purpose of using CBA in the process of assessing the sustainability of such projects. Martens (2011) and Pineda (2013) have demonstrated in various contexts how the use of travel time savings in CBA is not socially fair. The popular way to assess the benefits of reduced travel times is to evaluate the citizens' willingness-to-pay. Using the travel-time-savings criterion involves assessing the value citizens allocate to the time they spend commuting, which inevitably depends on their income rates. This gives more value to the time of the wealthy people – *"thus modelling investment in such a way will with no doubt give decision makers grounds to invest more where the privileged are located" (*Pineda, A. F. V. ,2013, p. 6). The time spent commuting is, according to this factor, more valuable for commuters with a high income as they are willing to pay more for their commute, since they can afford to.

The consequence of such a methodology is that the commute routes of the upper-class people appear to have a higher potential for new infrastructure projects than the zones where residents with a low-income live when using the travel-time-savings criterion in CBA.

Instead of using the abovementioned criterion, Martens (as cited in Pineda, 2013) recommends taking 'accessibility gains' into account, a better way to value the interest in a new transport option for the residents of the suburbs experiencing transport poverty. "*Accessibility can, in disaggregated form, be defined as the ease of reaching an important destination from a given origin, given a radius of activity based on a distance or time budget"* (Hansen, 1959; Lowry et al., 2012, as cited in Nielsen & Skov-Petersen, 2018, p. 37).

The accessibility gain criterion would be more advantageous to the people located in inaccessible areas since the implementation of any new transport option would drastically improve their ability to travel, whereas this factor would be of a less importance for the commuters from the zones of the city already provided with various transport options. Using this criterion would consequently tilting the balance in favour of the mobility-poor (Pineda, 2013).

However, replacing travel time savings with accessibility gains in CBA does not solve all the equity effects identified in Martens' paper (Martens, 2011). There is a need for complementary modifications in the decision-making support tool (i.e. CBA) to achieve equity between disadvantaged groups and the majority population (Martens & Di Ciommo, 2017).

3.2.2 Process-related critics

Beukers, Bertolini, and Te Brömmelstroet (2012) investigate the reasons why, in the Netherlands, the use of CBA is controversial in some contexts. By gathering a focus groups constituted of various actors of the urban planning discipline who have made use of the decision-making support tool that is CBA, the authors have collected some crucial feedbacks about the limitations and potential bias of the cost-benefit analysis. The use of CBA became compulsory in the Netherlands in 2007 due to the merging of the budgets of the Ministry of Transport and Water Management and Ministry of Housing, Spatial Planning and the Environment.

The authors argue that, on top of the recurring demonstrations of the limitations of CBA, mainly in the form of the technical aspects such as the difficulty to put a monetary value on some of the costs and benefits (Gössling et al., 2019), the limited criteria taken into account or the potential bias of the analysis; the controversy could also be related to the process of CBA. This argument is also confirmed by Damart & Roy (2009, p. 207) who argue that *"the complexity of the methods for calculating, weighting, discounting and monetizing helps to make CBA procedures comprehensible only to technical experts. Thus, elected officials, as well as the other stakeholders, such as associations of transport users or concerned residents, often find it difficult to understand them."* The authors argue that the process of CBA lacks transparency

and is therefore only accessible to a handful of experienced professionals, familiar with the decision-making support tool.

3.3 Calculation, calculability and calculative agencies

This chapter's focus is grounded in the analysis undertaken by Callon & Muniesa (2005) of the economic markets and their inner mechanisms. I will attempt to apply the authors' findings to the present study for me to clarify the decision-making process of the implementation of cycling infrastructures and eventually apply it to CS networks in France.

3.3.1 Economic Markets as Calculative Collective Devices

A starting point of this debate is the reductive definition of markets and their functioning opted for by neoclassical economic theory, according to which *"agents calculate because they are calculative by nature"* (Callon & Muniesa, 2005, p. 1229). In their analysis of economic markets, the authors propose a definition of the notion of *calculation*, as they describe concrete markets as calculative collective devices. The authors investigate the mechanisms and actors involved in the current calculation process of markets and define it as a three-step endeavour. They come up with a broad definition blurring the separation between judgement and actual *calculation* and shed light on "*the arrangements that allow calculation and those that make it possible"*. (Callon & Muniesa, 2005, p. 1232). Then, they investigate the calculability of goods and introduce the concept of *calculative distributed agencies* which allows for a better understanding of the pricing of goods in the fields of financial markets and mass retail.

By applying their definition of the notion of calculation onto the three elements constituting a market, namely the goods, the agents and the exchanges, the authors describe the calculative process allowing the valuation of goods (and services once they have been conceived as things) that leads to the exchanges. Finally, they describe what Callon named *intermediaries* (Callon, 1991, as cited in Rydin, 2013), that are the rules and material devices allowing the encounter between supply and demands. The approach of Rydin of intermediaries and the non-human actors' roles will be described later in this report in order to better connect the work of Callon and Muniesa (2005) to the mechanisms of CBA hereby investigated.

The following analysis is based on the reflection of Callon and Muniesa (2005) and appropriates part of the methodology to better understand the status quo of CBA and attempt to break away from it by suggesting an improvement in the field of cycling infrastructure public decision-

making. I will argue that, just like concrete markets, cost-benefit analyses are constructed as collective organised devices. Using an actor-network perspective, the core of the following will investigate the complex and dynamic interactions taking place within the market in order to get a grasp on how the decision-making support tool can be improved so as to be truly sustainable, not only from an economic point of view but also from a social and environmental point of view.

3.3.2 Meta-process

Callon and Muniesa investigate what calculation process and calculative agencies are responsible for what is commonly known as *market price*, which appears to be the cornerstone of current calculability of goods. The description of the meta-process made by Callon and Muniesa can be used to try and understand the mechanisms of CBA and eventually to unlock the potential of improving this decision-making support tool in order to include both public health and sustainability. Some would argue that such aspects are hard to incorporate in the current CBA process:

"CBA should limit itself to what it can do, and not try to meet requests to include ever more effects of which knowledge is lacking." (TABLE, R. , 2011, p. 13)

According to Callon and Muniesa*, "calculable goods, calculative agencies and calculated exchanges — define concrete markets as organized collective devices that calculate compromises on the values of goods"* (Callon & Muniesa, 2005, p. 1230). In the present study of the use of CBA in cycle superhighways projects, CBA would be the market, a complex calculative device, and the goods would be the factors to be priced in CBA. Then, the calculative agencies would be the public entities (or their economic consultancies) undertaking a CBA to analyse an infrastructure project. This meta-process of evaluating goods in order to be able to exchange them is defined by the authors as a calculation process which can be summarized into three steps:

1) the entities considered must be detached; 2) once they are sorted out, they are attached with one another (this step is subject to manipulation); 3) a result must be extracted. This process raises the question of the calculative power. Due to the variety of both actors and criteria that can potentially be included in CBA, the explicitness of the factors considered in the calculation process of CBA is of utmost importance.

3.3.3 Stabilization

To be measured, factors to include in CBA must be measurable. As CBA uses financial terms, the non-economic factors (such as improved health, liveability, enjoyability, etc) must be given a monetary value. Callon and Muniesa (2005) state that goods must go through two phases to be calculated in monetary terms, namely singularization and objectification. The former involves profiling the good. It is the actors' decision to 'singularize' a good to make it calculable. Pricing each of the factors included in CBA make them singular. The latter requires to stabilize the *"properties qualifying it"* (Callon & Muniesa, 2005, p. 1236). Stabilization is also necessary across the calculative agencies, since the process of calculation can take place *"only if goods can be calculated by calculative agencies whose encounters are organized and stabilized to a greater or lesser degree."* (Callon & Muniesa, 2005, p. 1245)

CBA is an agreement where some knowledge and assumptions have been stabilized. Including new aspects in CBA would involve destabilizing both the calculation process and the network of actors allowing for this calculation to happen. In the case of CS networks, based on the experience of the city of Copenhagen in using CBA for the past ten years, the new factors which would need to be included in the calculation process are related to both public health and sustainability in the broad sense of the term.

The questions raised at this stage relate to the organisation of the calculation process and the inner mechanisms of calculative agencies: How are they organised? Who is responsible for sorting these aspects? The actors who undertake a CBA own the calculative power. They are responsible for what Callon and Muniesa label the *framing*, which in an analysis of CBA relate to what is included and what is not. This framing is created by the actors undertaking the CBA. Due to the *"distributed nature of calculating agents"* (Callon & Muniesa, 2005, p. 1230), the calculation process might lack explicitness and the use of a socio-technical approach to the overall decision-making process is necessary. Additionally, the two case-studies of the CS network of Toulouse and Lyon show that some decision-makers in public entities might make decisions without using any calculative tools (S. Boux de Casson, personal communication, October 16, 2019), according to their preferences and influenced by other actors (M. Meylan, personal communication, January 6, 2020). Another reason why a methodology (and therefore a calculative tool) is so badly needed in cycling infrastructures projects in France.

3.3.4 Towards an ANT approach of the CBA process

Based on the calculation methodology identified by Callon & Muniesa (2005), I will now reflect on the identification of the factors to include in CBA, the way they are calculated and by whom. However, CBA should not be reduced as a calculative tool for decision-making support but should rather be perceived as a network made of human and non-human actors. Based on that postulate, the identification and evaluation of factors to be included in CBA are necessary but not sufficient. I will therefore address the issues of (calculative) power across the organizations and actors involved, along with the mechanisms that create the calculative framework, using ANT since *"this analytical framework is particularly well adapted to the study of the role played by science and technology in structuring power relationships."* (Callon, 1986b, p. 196)

3.4 Definition and objectives of ANT

Actor-Network Theory (ANT) is a methodological and theoretical approach to social theories which, by definition, aim at describing what society is. The purpose of ANT is to analyse how different actors from the same network can cooperate to achieve a common objective. The majority of social theories conceive society as a connection of humans, argue Callon (1986a) and Latour (1999), whereas ANT assumes that society is not only constituted of humans, there are some 'non-human' actors involved. The specificity of ANT lies in its focus on actors more than factors. This is what makes it different from other social theories. Everything that happens in society is made by a collection of humans and non-human actors. We, as a society, are constituted by technology and by human interactions.

The Actor-Network theory can be used to frame the changes needed to set up an alternative decision-making support tool to analyse, from a decision-making perspective, the potential of long-distance cycling infrastructures across French Metropolises.

In a first step, the theory will be used to define all the actors, their identity, their vision, their opinion on the project and the knowledge they have of it, which one of them could be the leader of such a project and, most importantly, where possible conflicts could be anticipated and avoided in order for the project to succeed.

Then, I will attempt to describe the existing decision-making process within public governance to identify the intermediaries and the roles the various actors attribute them. ANT provides a good framework to understand the dynamics behind a highly complex system of interactions,

relationships and controversies. According to this theory, there is no pre-given hierarchy of the actors, the different influences the actors of the network have are defined in the process of translation, throughout the four phases defined by Callon, namely problematization, interessement, enrolment and mobilization, which will be explained in section 3.4.4 .

The problem of introducing a new type of cycling infrastructures for longer commute trips, with all the human and non-human actors involved can be defined as a socio-technical system and therefore actor-network theory is an appropriate choice to discuss the current situation and possible future developments. ANT assumes that if there is a barrier to a development, it is due to some of the actors' design to limit the development. What could be seen as an obstacle in other social theories is actually considered as *actions* and *responsibilities* under the prism of ANT.

"[...]technical objects must be seen as a result of the shaping of many associated and heterogeneous elements. They will be as durable as these associations, neither more nor less. Therefore, we cannot describe technical objects without describing the actor-worlds that shape them in all their diversity and scope" (Callon, 1986, p. 23).

ANT is therefore a theory of socio-technical change, meaning that when (and if) something changes within society, it is never only a social change. Conversely, when a technical evolution rises, it is never only a technical change since it can have social consequences, for example making a good or a service more accessible or changing the behaviour of its users. Every change is then a mixture of social and technical aspects. Analysing the case of cycle superhighways in France from an ANT perspective is therefore appropriate since providing an accessible transport options between suburban areas and city-centre will, according to me, have consequences on the social fabric on both environments. Indeed, unlike motorways which often act as exclusive transport corridors since its users (at least the drivers) must own a car, have a driving licence, pay for registration and insurance, cycle superhighways are also accessible to the less well-off communities since bicycles are way more affordable than cars or can be hired using city-bikes systems or free-floating bicycles, allowing them to travel independently and potentially in a more flexible way than when using PT. For such reasons, the technical solution defended in this report (i.e. cycle superhighways) induces lots of social changes.

ANT also appears to be particularly relevant in the case of cycling infrastructures as many stakeholders are involved in the process of implementing these infrastructures. Therefore, applying the above-mentioned *sociology of translation* will allow for a better understanding of the mechanism(s) of power. Additionally, this theory is grounded in the postulate that all the actors involved are on the same level, no one of them being more important, which is an unusual and interesting approach when studying, among others, public entities which function according to a structured vertical hierarchy (see Figure 9). ANT provides a framework to understand the dynamics between the actors identified and study their interactions, relationships and controversies. Another fundamental postulate of this theory is that because the relationships between the involved actors are in constant motion, it would be irrelevant to try and map the controversies. The approach needs therefore to be dynamic, not static. ANT assumes that the knowledge is in the relationships, not in the books nor in the experts. There are no facts. Actor-Network theory is based on three principles hereby explained:

3.4.1 Agnosticism

ANT can be used as a methodology to understand the various mechanisms of power and more precisely the real distribution of power. The principle of agnosticism makes ANT a unique theory as human and non-human actors must been considered in an equal manner. When using an ANT approach, one must not investigate the studied topic with preconceived ideas on how things are functioning within the network(s) but should rather go interacting with the different actors (Callon, 1986a). The only way of knowing the actors is by interacting with them (interviews, direct contact, reading about them, observation). It is therefore useful to engage in a relationship with the actors to get to know them and then have a better understanding. Cooperating with leading consultancy Copenhagenize Design Co. has been a way for me to interact with many different actors of the bicycle urbanism world.

3.4.2 Generalized symmetry

The concept of *symmetry* (Callon, 1986b) refers to the use of the same type of analysis and vocabulary across the social and natural worlds. It must be respected when using ANT to facilitate communication and precision. Latour says we must avoid using different terms to describe the same conflict and describe the human and non-human actors in the same terms (Latour, 1999). The sociology of translation is one way to do so. It is the most popular way to enrol different actors using a common language. Because of the recurrent critics made of the

process of CBA, this type of sociology is clearly relevant in the case of a reflection on the use of CBA in cycling infrastructure planning.

"The opacity of the CBA procedures reinforces the technocratic nature of decision-making, in part due the fact that the instruments and the language used in the procedures are adapted to the type of reasoning and accounting common in the value systems of a particular category of actors, frequently making both instrument and language unintelligible for the majority of the other actors." (Damart & Roy, 2009, p. 208)

3.4.3 Free association

Finally, the concept of *free association* (Callon, 1986b) is complementary with the above-mentioned concepts of generalized symmetry and agnosticism as it involves the elimination and abandonment of all a priori distinctions between the technological or natural, and the social (Callon, 1986b). According to the author, the distinction between technological, natural and social systems is due to some of the actors' design to create such separation on purpose. When using an ANT approach, the concept of *free association* must be respected for the analysis to be meaningful.

The three fundamental principles of ANT defined above require ANT researchers to observe the various actors identified, and explain their relationships using the same language and methods. Other key concepts of ANT are necessary when investigating an existing network of actors. These will be introduced below.

3.4.4 4 moments of translation

The concept of *translation* introduced by Sociologist Michel Callon refers to the process of convincing and mobilizing some actors. According to Callon, the four moments are not sequential, they are synchronic and parallel. For instance, in the author's famous analysis of the lucrative scallops' industry of Saint Brieuc Bay (Callon, 1986b), the so-called *interessement* and *mobilization* moments are parallel. When the conflict between the fishermen started again, after the researchers proposed a solution (which was to bring fishing baskets from Japan), then the researchers were allowed to problematize. Enrolment, interessement, mobilization and problematization are always parallel processes. The case of the scallops of Saint Brieuc Bay shows the amount of work necessary to make things stable.

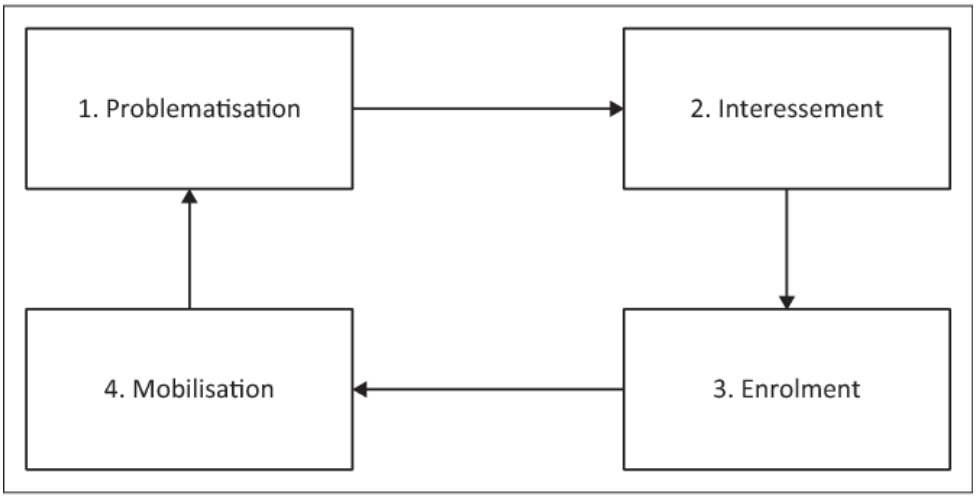

Figure 3 - Callon's four moments of translation. Source: Callon, M. (1986b)

3.4.5 Controversies

Controversies within identified networks arise in various ways and are never static due to the variety of actors involved, inducing a wide range of knowledge and visions. Understanding these controversies is however crucial to get a grasp on a network's status quo and eventually challenge the current paradigm by unlocking its limitations where needed. It is also of utmost importance to investigate the influence some actors might have on others, and to understand the nature of the resistance to the proposal made.

Actors act accordingly to the knowledge they have, if they have limited knowledge, then their capacity of acting is limited. In the present context of CS networks in France, the controversies as defined in ANT terms would suppose that French urban planners and decision-makers will estimate the costs and benefits of a CS network according to the knowledge they currently own.

Mapping the dynamic controversies and sharing these representations across the network will help increase the knowledge of each of the actors and participate in achieving a common objective.

3.4.6 Intermediaries

Prof Yvonne Rydin makes a distinction between intermediaries and mediators (Rydin, 2013). According to Rydin, an intermediary is someone who conveys a message, or a relationship, without changing it, whereas a mediator is someone who conveys a message, or a relationship, while impacting and modifying it. Rydin also believes that documents are actors. The way things are phrased is going to frame the interpretation, while both allowing and preventing some

understanding of the document. Rydin' s approach to the function of documents appears relevant in the hereby described project of CS networks and cycling infrastructures nowadays in France since both a legal framework recognizing the bicycle as a mode of transport (i.e. law LOM) along with a dedicated national fund (see section 4.1.4) were created in favour of the bicycle.

Finally, the goal of ANT is to show that a successful project involves all the actors. Planning success lies in all the interactions that are necessary to make a good plan happen, not in the quality of the plan itself. The next chapter will introduce the actors of the CS network under consideration in Toulouse, France, and detail their visions, relationships and work of influence.

4. ANALYSIS

4.1 Status Quo of Cycling in France

4.1.1 Designation of the mode

Like many European countries, France has experienced decades of urban landscape redesign for the benefit of the automobile from the 60s, changing people's perception of the bicycle. Until that time, it was however normal to commute by bicycle daily not only in large cities but also from towns to towns. Riding a bicycle to commute was popular among the population and was not only reserved to the people who could not afford to invest in a car.

In the 1990s, after becoming aware of the nuisance caused by the arrival of cars in large numbers in the urban, peri-urban and rural French landscapes, the public authorities combined walking and cycling by classifying them as "soft modes"[6], the main argument being the environment at the time (Papon & Dusong, 2016), and especially the consequences of the emissions of motorized transports on global warming. The *LAURE* law (1996) laid down the first environmental requirements for passenger transportation. The argument slightly changed in the early 2000s in favour of the benefits on people's health. The expression "active modes" appeared, explicitly referring to the benefits of physical exercise. Nowadays, this expression is still widely used, but does it suppose that the benefits of cycling have been taken into consideration in the development of cycling infrastructures and policies?

Papon & Dusong (2016) conclude their analysis of the health and environmental benefits of cycling by saying, *"But while the benefits of physical exercise are quantitatively greater than the environmental benefits, they still struggle to convince public opinion and decision-makers. There is therefore still an effort of promotion to be made so that the society benefits fully from the positive balance of the bike."* (p. 17)

Throughout the decades, not only the designation of the bicycle as a mode of transport has changed, but also the public opinion on it, one influencing the other and vice versa.

[6] "modes doux" in French

4.1.2 Public opinion on cycling

Since the 1970s, when the modal share of cycling averaged 10% in France (Mariani, 2012), this figure has largely decreased to reach 3% in 2018 (Plan Vélo et Mobilités Actives, 2018, p. 6). The government has even announced, according to the results of a survey on the transport habits of the French residents, that *"only 2% of the active population use the bicycle to go to their place of work"* (Plan Vélo et Mobilités Actives, 2018, p. 6). These alarming figures, combined with the government's desire to limit public expenses, improve public health and solve congestion problems as a result of decades of 'car-centric' planning[7], prompted the Minister of Transport in 2012 to question the duty of the government to encourage more citizens to ride a bicycle, a mode of transport they had since considered as a leisure activity (Guidez et al., 2003). Additionally, according to Papon & Dusong (2016, p. 4), *"it is the perception that conditions the practice. But most of the literature deals with real risks and real benefits."* Cycling in therefore not attractive enough in France. There is a need for studies about the perceptions of risks and benefits by cyclists.

4.1.3 A local approach due to lack of national structure

The pioneering French cities in terms of bikeability have not waited for national governance on this subject and have for years been creating their own active mobility plans, or even their own technical guides. This is for instance the case of the metropolis of Lyon, which, based on recommendations from the CEREMA[8] and best practices sourced across the country, has designed its own technical brochure for the development of cycling infrastructure within its metropolitan region. Strasbourg, the most bicycle-friendly city in France, with a modal share of 9% of cyclists, along with Bordeaux and Paris, have for many years centralized their budget and skills on the metropolitan level. This coherent local governance was also due to the distribution of the political duties on the national level. Indeed, in France, metropolitan governments are the transport authority, meaning that they must govern the development of the abovementioned modes of transportation.

In terms of investment, city and metropolitan governments are undeniably the central actors in infrastructure development, since they invest a lot more than the regions (H. Bécart, personal

[7] term used in Colville-Andersen, M. (2018).
[8] introduced in chapter 4.2.3

communication, December 12, 2019). The investment therefore comes, from the political point of view, from the local and not the national level. These differences between metropolises also translate into different ambitions. Since some French cities are much more advanced in terms of cycling and investment policies, the objectives of modal shares vary. Some cities also want their voluntarism in favour of cycling to inspire others and have challenged themselves by setting ambitious goals.

4.1.4 Political voluntarism

Unveiled in September 2018, The "Bicycle and Active Mobility Plan" was the first national engagement on cycling policies and incidentally the first joint commitment between the Ministry of Transportation and the Ministry of the Ecological Transition. The initial version of this plan was started in 2012 after the request of the Minister of Transport at the time (Mariani, 2012). A working group bringing together local politicians, advisers, and members of the associative world was created to reflect on the development of the use of the bicycle in general in France. The ambition at the time was to raise the national modal share of cycling from 3% to 10% by 2020 (Mariani, 2012). In September 2018, the aim of the government was to reach 9% by 2024 (Plan Vélo et Mobilités Actives, 2018, p. 3).

From the perspective of national decision-makers in France, cycling as a mode of transport became a major topic only since 2012. After being considered as a recreational activity for decades and entrusted to the Ministry of Sports, the discussions on the bicycle as an eco-friendly mode of transportation appeared in the scope of the Ministry of the Environment[9]. In 2018, former Minister of Transports Borne was named Minister of Ecological and Inclusive Transition.

This evolution of the governance has clearly impacted the government's vision towards active modes. The appointing of a former Minister of Transports has strengthened the government voluntarism in favour of sustainable modes of transport.

[9] This Ministry was renamed many times, sometimes even within one President's mandate.

4.2 The Actor-world of CS networks in France

Based on the description of the context of this analysis and the definition of the decision-making support tool (i.e. CBA), this chapter aims to apply the methodological and theoretical framework chosen (i.e. ANT) to the case-study of the CS network under consideration in Toulouse, France. This project will also be an opportunity to study an effort to create synergies and coalitions among several bureaucratic and technocratic entities within public governments and the associative and private networks in France. In this chapter, I seek to describe the complex relationships between the human actors involved in the development of cycle superhighways in France whose influence, decision-making power and knowledge might shape the outcome of a cost-benefit analysis. The following classification is by no means exhaustive nor are the relationships described static, it reflects the knowledge gathered during this project within the context of a cooperation with consultancy Copenhagenize Design Co.

4.2.1 Methodology

To get a grasp of the dynamic relationships between the actors (both human and non-human) of the 'bicycle urbanism' world, I wanted to cooperate with a consultancy and see how the knowledge that they own is shared and influences the development of bicycle infrastructure in cities. Also, the frequent use of consultants by public entities had me question the type of knowledge and skills exchanged and priced. Indeed, the city of Copenhagen had mandated private consultancies COWI (Willumsen & Roehl, 2010), then INCENTIVE (INCENTIVE, 2018) to create and update the city's CBA model named TERESA. Also, in the Netherlands, the Ministry of Transport had mandated consultancy DECISIO to analyse various cycling infrastructure projects (Erznoznik et al., 2014).

The data-collection process judged adequate to provide the following information was made in three steps:

1. Literature Research
2. Cooperation with Copenhagenize to investigate the status-quo of CS in France
3. Interviews (either facilitated by Copenhagenize or organised independently)

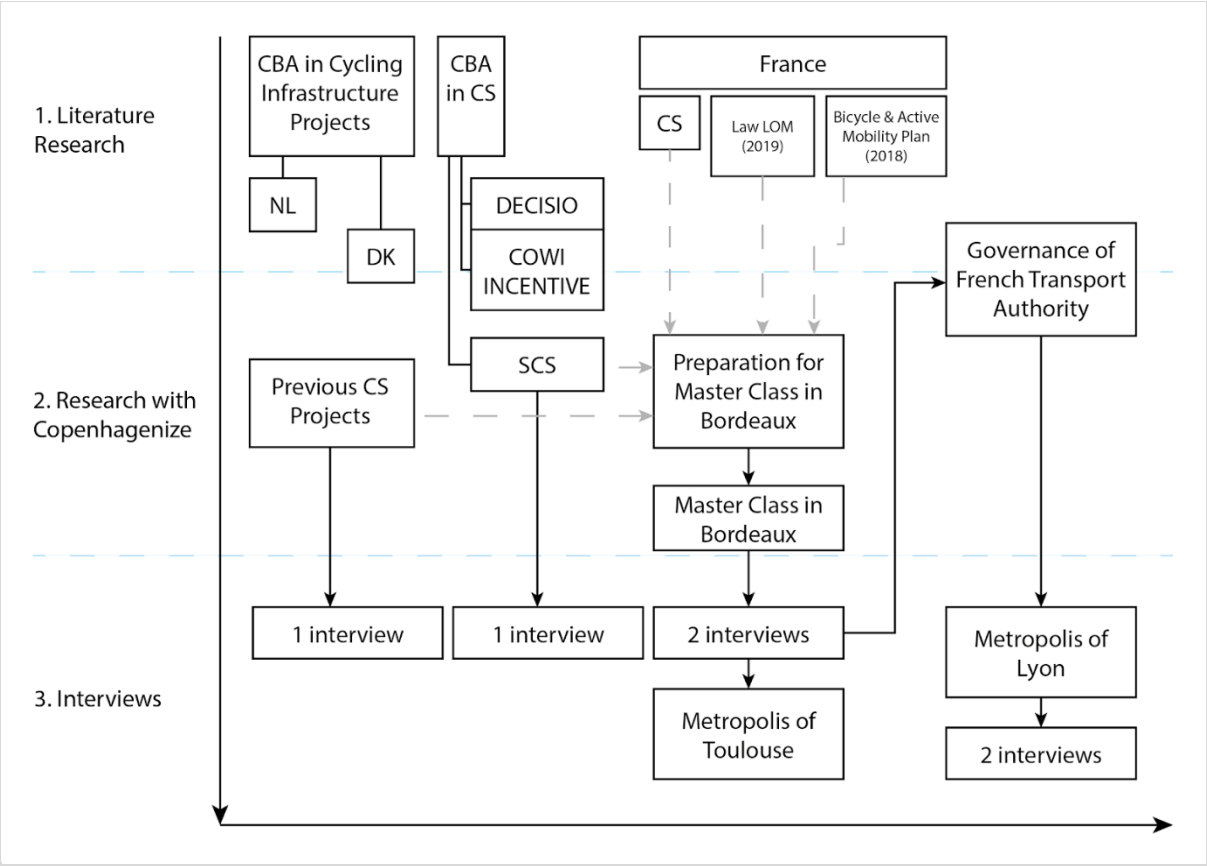

Figure 4 - Data-collection process. Own illustration

The above illustration represents the project's data-collection process undertaken to try and answer the research question. As shown in step 2. (i.e. Research with Copenhagenize), the cooperation undertaken with the firm was central in the process of connecting a variety of human actors and also in exemplifying the knowledge found in the available literature focused on both CBA, ANT and CS networks across Europe.

4.2.2 Investigation

To collect the opinions of experienced professionals using CBA, Beukers et al. (2012) have gathered a group of urban planners, policy makers, politicians, academics and lobbyists. The authors' approach of the data-collection process falls under the scope of the Actor-Network Theory. The authors seek to understand how knowledge is created and transmitted among this sample group. To reflect on the decision-making support tool, the authors investigate the visions of each of the actors and their frustrations.

From an ANT perspective, Haezendonck (as cited in Beukers et al., 2012, p. 69) addresses *"the importance of involving stakeholders in CBA processes, which does not seem to be a natural element in current CBA practices. However, the incorporation of stakeholders in the CBA process could be difficult, because the CBA is based on welfare theory and compensation criteria, whereas each stakeholder has its own set of costs and benefits"*.

This argument also refers to Callon's four moments of translation, being the process to convince and mobilize (Callon, 1986). As explained in section 3.4, the purpose of Actor-Network Theory is to analyse how different actors from the same network are performing together to achieve a common objective. Using ANT's methodological and theoretical approach of social theories, the next chapter aims to describe the relationships between the various institutions and actors involved in the project hereby studied.

4.2.3 Definition of the human actors

A fundamental step when using actor-network theory is to define the involved actors and describe them. The following classification is by no means exhaustive nor static, it reflects the knowledge gathered during this project within the context of a cooperation with consultancy Copenhagenize Design Co.

- Human Actors (Public, Private & Civil Society)

National government	Public entity
Regional government	Public entity
Departmental government	Public entity
Metropolis government	Public entity & Metropolitan Transport Authority
Urban planning agency	Technical advisers
Intercommunal government	Public entity
City government	Public entity
Mayor(s)	Public figure(s)
National Rail	Railways Operator
National Highway	Highways Operator
PT operation company	PT Operator
Tisséo (case-study Toulouse)	Technical advisers & Metropolitan Transport Operator
CEREMA	Technical advisers
Researchers	Research
Economic Consultants (e.g. COWI, INCENTIVE, DECISIO)	Consultancy
Mobility Consultants (e.g. Copenhagenize Design Co.)	Consultancy
Real estate developers	Land developer
Cyclists Federations (e.g. FUB)	Grassroot activism
Bicycle Users	Cycling infrastructure users
Potential Bicycle Users	Potential Cycling infrastructure users

Figure 5 - List of human actors of the CS network in Toulouse. Own illustration.

- Non-Human Actors

Law LOM	Intermediary - legal framework
Masterplan (*Schéma Directeur*)	Intermediary - planning framework (metropolitan)
Bicycle and Active Mobility Plan	Intermediary - transport planning framework (national)
Active Mobility Action Plan (*PAMA*)	Intermediary - transport planning framework (metropolitan)
Urban Mobility Plan (*PDU*)	Intermediary - transport planning framework (metropolitan)
Bicycle accounts	Tool
Transport Modelling tools	Tool
CBA	Tool
Cycle Superhighways (*REVe*)	Cycling infrastructure

Figure 6 - List of non-human actors of the CS network in Toulouse. Own illustration.

- Public entities

Transport Planning is a vast discipline where a variety of actors are involved in the process of implementing a transport infrastructure. Cycling infrastructures planning is no exception to this rule. Indeed, both the interviews conducted and the research into French public administration organizational charts have shed light on specific entities often unknown to the civil society, and especially to the ordinary bicycle users who might address their local public entity directly to discuss a potential issue with the bicycle infrastructure of their city. French public administrations are organised under a complicated vertical hierarchy, where elected leaders must cooperate with technical advisers (see Figure 7 below) to define new projects and share the responsibility between the political aspects or urban planning and the technical (and social) aspects. These relationships are unstable since both actors have a different decision-making powers and competences. The activities of technical advisers (namely the CEREMA, Tisséo and Urban Planning Agencies) will be detailed later in this chapter.

Public entities own the decision-making power over various competences but have limited budgets and short-term vision due to political mandates. However, they benefit from a relative stability within these mandates[10]. Depending on their way to tackle mobility-related issues, on their vision of the future and their desire to promote the bicycle as a mode of transportation, elected leaders can reshape the urban fabric of the territory they are responsible for. Such figures are often approached by representatives of different groups, be them official lobbyists or activists, to discuss each of their visions. Elected leaders and their team are therefore the visible actors or the urban planning world. They must manage the opposing opinions of the actors of their network in a rational manner so as to try and please the majority, while not making unreasonable moves that could endanger their popularity. The discussion of the vision of individual politicians and their boldness to challenge the existing transport paradigm is vast and falls out of the scope of the present analysis which emphasizes on the decision-making support tools rather than the politicians' personal convictions. However, the above described the unstable position where elected leaders find themselves during their mandate. Damart & Roy (2009) explain this challenging position where making decisions regarding a transport infrastructure or choosing between various options can be a delicate task:

"[…] when choosing among alternative investment projects, the decision-makers reveal the priority they have assigned to the different stakes, and these priorities must be perceived as

[10] Unlike, for instance, consultants whom activity varies depending on their projects

legitimate. Thus, decision-makers must both spend their limited resources with special care and make the most acceptable decisions possible." (Damart & Roy, 2009, p. 201)

The present analysis emphasizes the lack of methodological decision-making support tool in cycling infrastructure planning in France, and more precisely at the dawn of large CS networks planning. The explanation of the relationships between the actors involved and those who might not be yet is therefore crucial to challenge the existing paradigm of decision-making.

- The Metropolis government

One of the main protagonists of the CS project is the Metropolis government, which acts as the Transport Authority for the metropolitan area, responsible for the management of all transport infrastructures projects including budgeting, planning, coordinating the several actors involved, and making decisions. Due to its crucial role in the economic, social and environmental development of its perimeter, the Metropolis government sets objectives to be reached by the end of the political mandate. They finance (with other public entities) the Urban Planning Agency (UPA) specific to their metropolis, which consults on their behalf, with a certain freedom and therefore a longer-term vision than the metropolis government, which manages the short term and the more political challenges (A. Duhamel, personal communication, October 17, 2019).

The Head of this public entity, namely the President of the Metropole, is consequently a politicized actor focused of reaching the above-mentioned goals within a defined time window and budget.

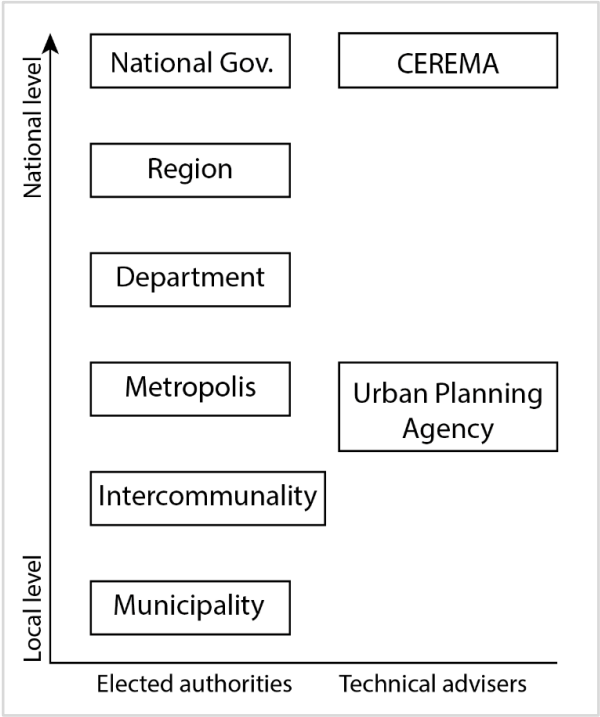

Figure 7 - Elected authorities and technical advisers. Own illustration

- Urban Planning Agencies

To cope with such short-term imperatives, the Metropolis governments cooperate with their related urban planning agency (UPA) which gathers various disciplines of City Planning, including Mobility Experts. This agency is financed by public funds and provides the engineering expertise required by the Metropolis government to study each project in detail. They also collect a lot of data and work on projects on the long term, studying the technical, financial and environmental feasibility of various types of infrastructures. Their cooperation is essential to envision long-term goals and define milestones. The Head of the Urban Planning Agency works closely with the elected official in charge of mobility-related projects at the Metropolis government to manage the scope of the projects and define priorities.

- Consultants

Consultancies provide guidance on design, strategies, action plans and communication strategies to elected officials and their teams. As any private company, they must make profit to sustain in the future and are therefore dependant on the workload they receive from the client cities they work for. Urban planning consultants mainly perform for public entities wishing to elaborate a strategy towards a more bicycle-friendly environment. Depending on their budget, the client cities can mandate private consultants to learn more about a specific topic or subcontract a phase of a defined project. When it comes to bicycle urbanism, many public entities lack experienced professionals and therefore need an external look on their urban planning projects. Urban planning used to be a discipline of architecture studies therefore many professionals were not trained specifically to design infrastructures for cyclists or any other active modes of transportation.

Also, since public entities must spend their budget each year (budgets for municipal departments are made for each calendar year), consultants seek to maintain a stable relationship with public entities to be mandated regularly. The relationship between consultants and urban planners from the public sector is constantly evolving, as the projects and the budgets might change over time, which might affect the duration of the contract or the level of guidance public planners can afford.

Consultants have no real decision-making power within the urban fabric, they influence the decision-makers and provide guidance. They create awareness about the benefits and potential of cycling as a mode of transportation. They share their vision of what a sustainable city could

be and how the bicycle could contribute to achieve this goal. Many consultants have worked for public entities during their career and therefore know the inner mechanisms of public entities.

This relationship between public entities and private consultancies is not only a commercial operation, where the good sold is a service, but it is also an activity of influence and perspectivation of the global active mobility options of the client city. Consultants not only give advices and provide design recommendations, they also carry a vision, and try to convey an inspiring message understandable by all. Their discourse can be adapted to their audience. When addressing elected officials, their argument will emphasize on strategies, vision and social aspects, whereas when technical departments, road directorate members or civil engineers are part of the discussion, consultants' vocabulary will become technical.

Not only do they show facts, figures and images of bicycle-friendly cities and their achievements, they also make public urban planners and decision-makers appropriate the vision. Documents and visual presentations are highly important intermediaries in the process of influencing. Consultants either act as mediators or intermediaries themselves, depending on what message they carry. For instance, when sharing figures about the bicycle modal share of the capital region of Denmark, consultants become intermediaries, they share an information without impacting on it. However, when they discuss design and strategies, they adapt the content of their message to the context of their audience and are consequently mediators.

- Researchers

Researchers create more knowledge material, which is shared through publications to other researchers, students but also public and private entities. For instance, their results can feed consultants' argumentation, and to some extent influence urban planners from public entities. ANT states that knowledge is in the connections between the actors, it is transmitted. Researchers findings and publications are therefore important intermediaries in the process of sharing the latest knowledge on a variety of topics.

In Copenhagen, Denmark, researchers from DTU (*Transport økonomiske enhedspriser*), have contributed to the incorporation of health benefits in the CBA model used by the City of Copenhagen to analyse different alternatives when considering a new cycling infrastructure, by providing the data on health included in the model (A. H. Garrett, personal communication, November 20, 2019). Indirectly, researchers contributed to the decision-making process by

sharing their findings and therefore creating more knowledge for the whole actor-network involved in the project.

- Transport Modelling tools

Transport Modelling tools (TMT) for cycling are not as developed at the ones used to model motorised traffic flows (Van Ommeren et al., 2012), which benefit from a sophisticated technology for a long time. The technology to measure the bikeability of any city and the costs and benefits of a specific infrastructure is incomparable with the tools used by both the automobile industry, navigation companies and motorways operators to get an accurate overview of traffic flows so as to provide motorists with the best conditions.

"A transport infrastructure project will affect travel times and more generally the benefits of travel that accrue directly to users. Traffic models help analysts form a picture of what these direct effects will look like. Measuring user benefits is far easier than tracing the ultimate incidence of project impacts throughout the economy, and therefore provides a practical avenue to producing robust results relatively quickly. Practicality, however, comes at a cost in terms of scope and policy-relevance." (TABLE, R., 2011, p. 5)

Regarding cycling, the tools used make it possible to analyse the evolution of the cycling policies led thanks to the figures obtained, however, the on-street totems (type of counting tool popularized in many big cities) do not take into account neither the qualitative aspects nor the profile of the cyclists. It is therefore necessary to observe other parameters in addition to the use of totems. Also, traffic simulators cannot simulate modal shift which limits their functionality. (S. Boux de Casson, personal communication, October 16, 2019). TMT are widely used by public entities to gather data on the use of specific segments of cycling infrastructure and use their results to forecast a strategy towards the end of the political mandate.

These figures are also mediatized to show the accomplishments of the city and promote the use of the bicycle to potential users. As explained above, such tools are therefore limited to a basic analysis which is hardly compatible with a CBA which requires a variety of information, often supplied by researchers and Ministries.

"Include the bicycle in traffic models: if public transport and cars are included in a traffic model, the bike is mostly excluded. But since bike use may be a relief to traffic and public transport, it is recommended to pay more attention to it." (Van Ommeren et al., 2012, p. 7)

- Grassroots activists

The French Cyclists' Federation (FUB) voices the opinions of its members through the intermediary of its local cyclists' unions which try to enrol bicycle users from their respective cities or towns. The FUB has become more and more influential on the public level due to its activities spanning from encouraging city dwellers to cycle, communicating on the benefits of riding a bicycle, and even collecting data on the use of the infrastructures and especially the opinions of their users. To do so, the FUB sets up an online questionnaire every second year, asking bicycle users to give their opinion on the bikeability of the city they commute through. The results of this questionnaire provide information on the national level and allows the FUB to create a ranking of the most cycle-friendly city of France according to their criteria. The ranking is often used by elected officials as a tool for their communication strategy or to show their accomplishments. It can also be used as an intermediary between different cities to challenge each other's to try and improve their positions in the national ranking. The last edition of this survey was online for three months late 2019, so that the results can be unveiled before the French municipal elections in March 2020. The board of the FUB expects these results to support the political discussions about the bicycle as a mode of transportation.

The FUB was invited to the discussions concerning both the law LOM and the Bicycle & Active Mobility Plan and has successfully advocated for the rights of bicycle users. This cooperation between public entities and activists (see Figure 8) was fruitful since the above-mentioned documents give both a legal aspect to cycling and a dedicated budget on the national level. Using a bicycle for transportation is now recognized in the eyes of the law and the country's transportation budget.

The activists therefore have a certain influence on the decision-making process. Due to their organised hierarchy (local unions enrol commuters and are themselves members of the national federation), the FUB is able to deal with a variety of actors from both the civil society, public entities and private companies.

Even though their activities, methods and constraints are different, activists and consultants share a desire to improve the conditions for cyclists in their city.

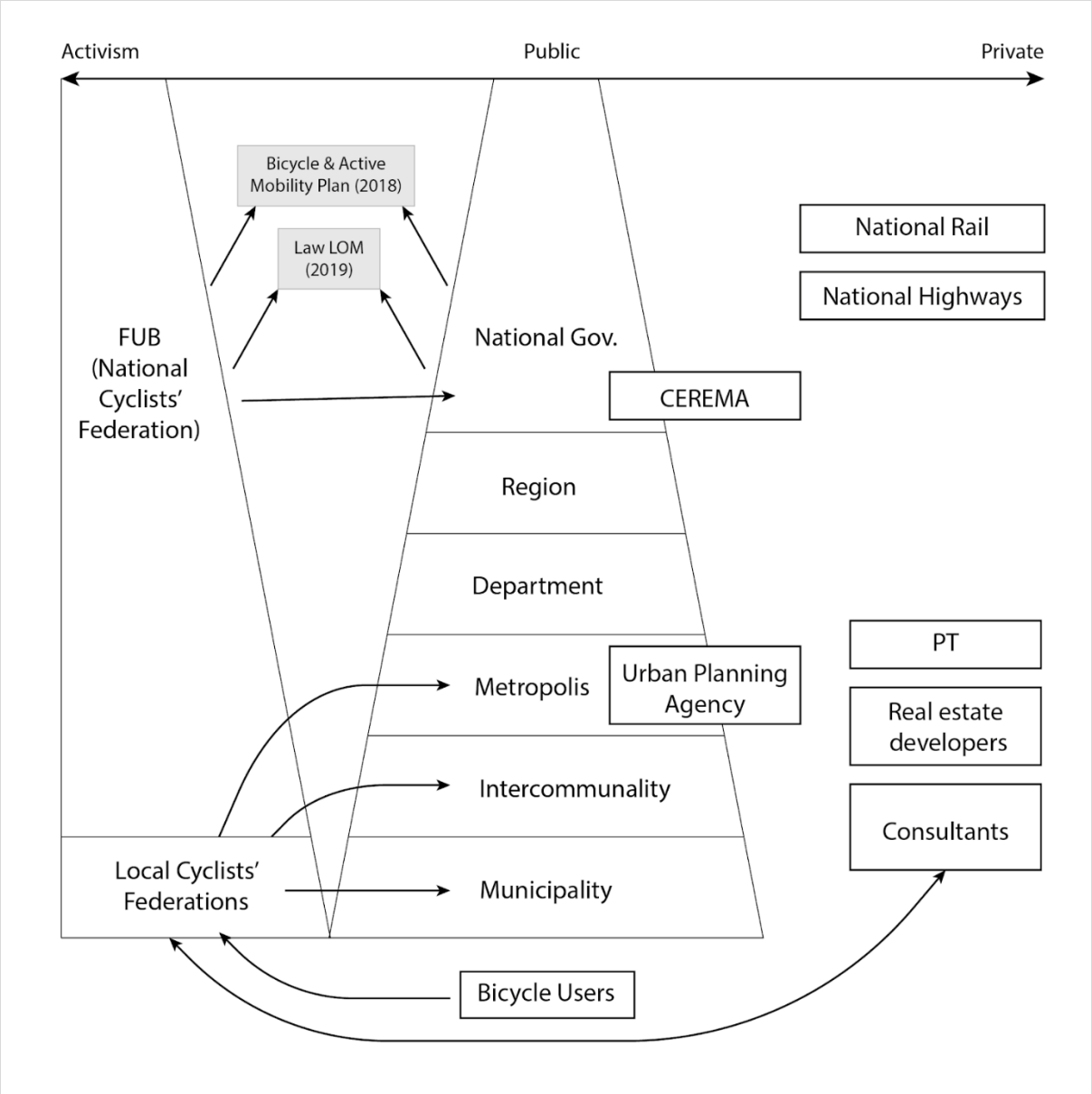

Figure 8 - Cyclists Federations' connections with bicycle urbanism world. Own illustration

- CEREMA

The CEREMA is an entity created by the Ministry of Transportation to provide national guidelines on bicycle infrastructures and various disciplines of transport planning. The CEREMA provides recommendations based on best practices sourced in countries such as the Netherlands, Belgium and Denmark but these have no regulatory value. Each of their technical guides starts with the following note:

"This method sheet has no regulatory value. It must be seen as a decision-making tool, an incentive to improve the consideration of cyclists in the infrastructure." (CEREMA, 2016, p. 1)

Among the many guides provided by the CEREMA for Transport Planners across the country, none of them is specifically made to provide recommendations on CS. As per today, no regulation exists regarding the technical standards to follow when implementing a cycle highway in France. The words *cycle highways* and *cycle superhighways* do not appear (yet) in any of their deliverables. One of their guides is focused on cycling networks with a "high level of service" (CEREMA, 2016), and gathers best practices across Europe of qualitative infrastructures but does not necessarily CS. The current focus is rather on wide bicycle tracks and *bicycle streets* rather than CS.

This lack of categorization of CS in France by the CEREMA has created confusion among Transport Planners developing such networks. This confusion has incited them to source best practices abroad, where standards might vary from one country to another. Some French metropolises such as Lyon have even created their own technical guides for cycling infrastructures, which invites the municipalities included in the metropolitan area to implement a coherent type of infrastructure.

As seen across this chapter, the actor-network of the entities involved in the development of a CS network in France is vast and unstable: many actors face different challenges, be them political, financial or sometimes technical. The next chapter provides an overview of the protagonists of the case-study of the CS project in Toulouse using an ANT perspective. New actors and intermediaries will be introduced to better understand the mechanisms leading to the implementation of a CS network.

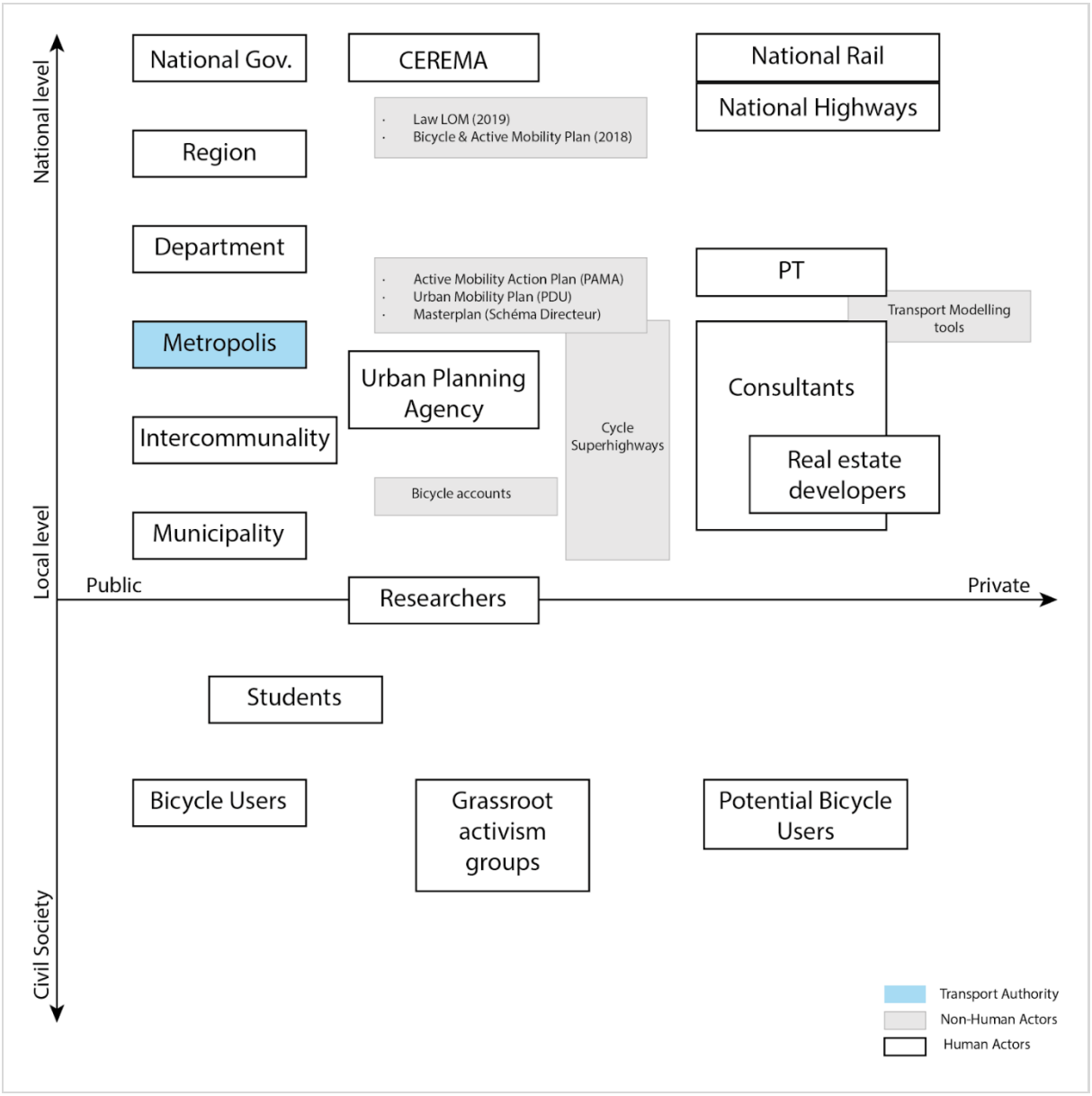

Figure 9 - Map of actors in France. Own illustration.

4.3 Case-study: Cycle Superhighways in Toulouse, France

Due to the scarcity of available information regarding cycle superhighways in France, the data collection process was conducted partly through interviews. The cooperation undertaken with consultancy Copenhagenize Design Co. has facilitated the connection with the protagonists of the upcoming CS network of Toulouse, France, which was consequently chosen as the case-study. However, an extensive review of the current knowledge about CS in France was conducted. The case of the metropolis of Lyon, France, also appeared interesting due to the unique governance of this region (presented in the next chapter). Two interviews were

conducted with members of distinct Urban Planning Agencies of the metropolis of Toulouse. Another two interviews were conducted with Transport Planners of the metropolis of Lyon.

Unlike other metropolises such as Grenoble and Strasbourg where large CS networks were implemented some years ago, the decision in Toulouse was made recently, which provides the opportunity to study the implementation phases from the very beginning of the process.

4.3.1 Problematization

The responsibility to design a complete CS network spanning across the metropolis of Toulouse (and more) was allocated to a special entity of the metropolis government named Tisséo, in charge of various transportation modes, from the engineering of the systems to its operation. Tisséo therefore owns an interdisciplinary knowledge of the metropolis' transport networks. This public/private entity was tasked with representing a group of actors and synchronising the process of defining a 370 km-long CS network outreaching the metropolis border (see Figure 10), therefore involving additional public entities and consequently additional actors. Indeed, the segments of the CS network located outside of the metropolitan territory - representing 50 km of the cycling infrastructure - will be financed by the department government (S. Boux de Casson, personal communication, October 16, 2019).

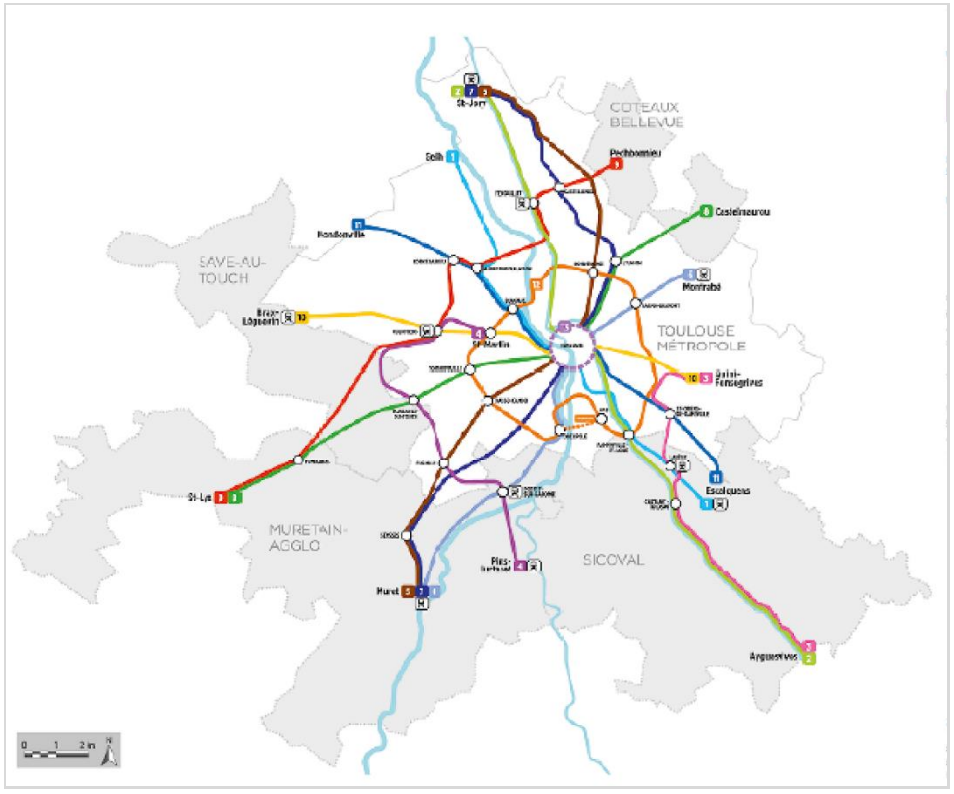

Figure 10 - Planned CS network in Toulouse, France - Source : Tisséo Collectivités

4.3.2 Interessement and enrolment

Due to their responsibility in defining the future network of the cycle highway on the behalf of the Toulouse Metropolis, Tisséo must convince the other protagonists of the project that the implementation of the cycle highway network is viable.

A consensus exists between some of the human actors, namely the activist association, the mobility consultants and Tisseo: cycle highways are a necessary and viable investment for the Metropolis of Toulouse. Their approval is obtained in advance. However, some of the investors and decision-makers must be convinced, a lot of negotiations in therefore necessary. Due to their sprawl across a whole metropolis area, CS cross several municipal borders, which multiplies the actors to be convinced. Also, since CS are relatively new in France, some of the actors might be sceptical about the potential of such infrastructures and the viability of the project. A decision-making support tool would be particularly helpful when enrolling sceptical actors to reinforce the argument in favour of CS.

4.3.3 Mobilisation

Within the Actor-network of the CS project in Toulouse, many entities are representatives of other actors (see Figure 11). For instance, the intercommunalities represent a gathering of more than a hundred municipalities. Even if an agreement is reached in favour of the development of cycle highways, will all the municipalities respect the agreement and build the infrastructure the way they are expected to? Will they follow their representatives (i.e. Tisseo) ?

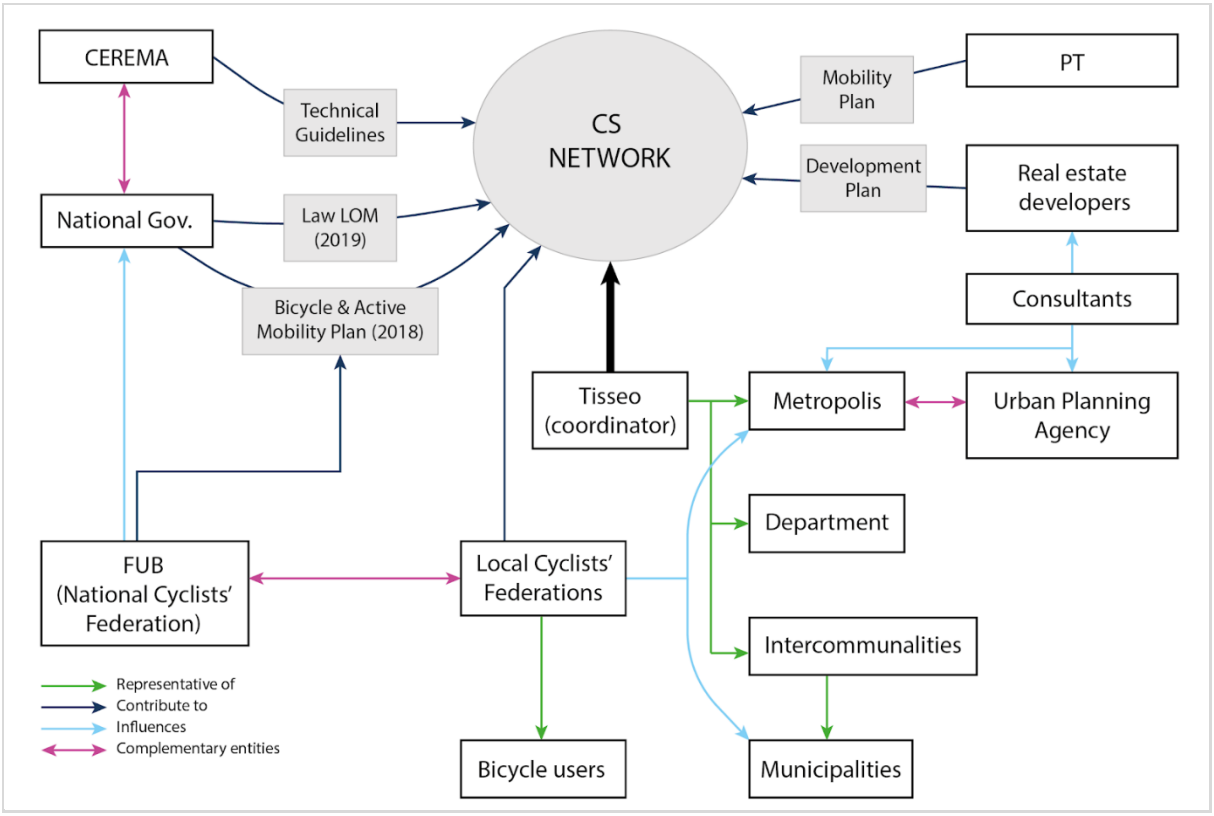

Figure 11 - Actor-network of the CS project in Toulouse, France. Own illustration.

The description of the actors involved in cycling infrastructures projects shows how heteroclite and unstable the actor-network currently is.

4.4 Case-study: Cycle Superhighways in Lyon, France

As seen in the last chapter, a network of actors and intermediaries are involved in the transport policies and decisions made by the metropolis government. Even though all the French metropolises are tasked with managing the transport system, some of them are more advanced in their profusion of policies in favour of cycling, or in their power on the urban fabric. The case of Lyon will now be presented for two reasons:

1. It represents an interesting example of innovative governance.
2. A CS network is currently under consideration.

I will therefore transcribe the knowledge collected from the two actors of the metropolis interviewed.

4.4.1 Unique status

The metropolis of Lyon, second largest metropolis in France, benefits from a unique status as it owns most of the roadways within its area, unlike the other French metropolises where each municipality is the owner of the roadways on its territory (H. Bécart, personal communication, December 12, 2019). Since January the 1st of 2015, the metropolis government has absorbed the public entities formerly known as intercommunal governments and departmental government to become one single entity. The metropolis is since the authority responsible for not only transportation but also social concerns (such as disabled access, childhood protection, etc). The 59 municipalities included in the metropolis government are therefore responsible for a reduced workload and their decision-making power is reduced. Most of the competences and duties are now gathered under one single governance scheme (M. Meylan, personal communication, January 6, 2020).

To synchronize the work towards a more bicycle-friendly metropolis and gather the actors involved, the metropolis government created in 2013 its own technical guidelines to implement cycling infrastructures. This document was meant to act as a reference for all bicycle infrastructures projects. It was created by a consensus of local actors, including the most influential local activists group which regularly sits at the table of decision-makers during discussions about cycling in the metropolis. Strong of almost 1500 members and still growing, the local cyclist federation is now part of the decision-making process and brings opinions and suggestions from bicycle users (M. Meylan, personal communication, January 6, 2020). The federation has grown exponentially for the last few years, becoming more and more visible to the eyes of decision-makers and candidates. Their opinion is heard because it represents the voices of many bicycle users across the territory who collect data and consequently create knowledge about the metropolis' bikeability.

The document was also co-created in cooperation with the PT representatives and the technical teams of the metropolis so as to implement a coherent cycling infrastructure across the metropolis, and ease the design process for each of the municipalities (H. Bécart, personal communication, December 12, 2019). This document was inspired by the technical recommendations provided by the national CEREMA, the entity created by the national government to provide guidelines to the transport authorities across the country. The guide acts

as an intermediary between the transport authority (i.e. metropolis government) and each of the municipalities involved in a cycling infrastructure project. By creating this intermediary, the metropolis government and the abovementioned contributors desire to stabilize the current knowledge about cycling infrastructure within their network.

The case of Lyon is particularly interesting since the transport authority owns the roadways, as explained above, which makes the metropolis government a strong actor - and a strong network itself - as the need for negotiation is theoretically reduced since less controversies can happen (due to less connections between the actors). This particularity can play in favour of implementing a cycle superhighway network across the metropolis in a structured way. This topic has been discussed among the actor-network and activists are trying to influence the candidates to the 2020 elections to support the CS project, arguing that the achievements of the metropolis (creating its own guide for instance[11]) will ease the implementation of a qualitative CS network.

However, several conflicts persist within the actor-network of transportation entities within the metropolis. Even though the metropolis government owns the roadways across the 59 municipalities and 9 boroughs included in its territory, the implementation of cycling infrastructures is the result of many discussions and analyses and requires all the actors to get involved and agree on the project. The present analysis was undertaken only a few months before the municipal elections (March 2020) and during the passing of the bill on active modes of transport, unveiled in December 2019. The political context was consequently very unstable as mobility-related matters had become very mediatized, especially on both the municipal and metropolitan levels of governance.

4.4.2 An indispensable actor

The metropolis government, as explained above, coordinates the many actors of the metropolitan network which includes both grassroot activists, elected officials, candidates to the municipal election, PT operators but also private actors. I will now investigate the visions of each of them.

[11] The guide does not provide recommendations on CS yet, but a new version will be published in 2020 with recommendations made in cooperation with the CEREMA. (M. Meylan, personal communication, January 6, 2020).

- PT operators

PT operators representatives are present during the negotiations of large cycling infrastructures projects such as CS due to the need for bicycle users to both share some of the metropolis' bus lanes (when no better option is provided) or cross the tramway tracks. The perspective of PT operators is two-fold:

1. Commercial speed concerns

Cycle Superhighways - and separated bicycle infrastructures in general - might require allocating one traffic lane to bicycles, which would make motorised traffic denser on the other lanes and consequently slow down the buses' commercial speed.

2. Road safety concerns

According the PT operators, bicycle users behave dangerously, which could induce accidents with tramways and buses. The representatives of PT operators base their argument on local newspapers reporting a collision between, for instance, a bicycle and a tramway and do not show empirical evidences of the occurrence of such crashes (M. Meylan, personal communication, January 6, 2020).

Due to the recent massive investments in PT infrastructures across the metropolis, PT operators are powerful actors who wish to keep their authority unchallenged. According to Meylan (M. Meylan, personal communication, January 6, 2020), decision-making support tools such as CBA would show how expensive such mass transportation infrastructure actually are compared to CS and how much they rely heavily on public subsidies.

- Mayors

The 68 mayors of the metropolis (59 municipalities and 9 boroughs) do not share the same vision towards cycling infrastructures. According to Meylan, (M. Meylan, personal communication, January 6, 2020), they can be categorized into three groups, which I have named as follows:

- Sceptical: Mayors who have shown for years their opposition to any cycling infrastructure project on their municipality and refuse to even discuss such matters. Convincing them is very challenging.
- Interested by concerned: Mayors who need to be convinced of the benefits of cycling infrastructures for their municipality. They might lack information about the costs and benefits of cycling for their municipality.

- Already convinced: Mayors who know very well the benefits of cycling for both citizens and their municipality and are often bicycle commuters themselves.

Depending on whom the metropolis government Urban Planners address regarding a cycling infrastructure project, the process of convincing and mobilizing can be different. Indeed, the arguments presented by the Urban Planners, their discourse and the facts that they provide will be adapted to their audience.

The current context of the upcoming municipal elections, along with the growing popularity of cyclist's federations, the demands for the private sector for better conditions for bicycle users among their workforce (explained in the next paragraph), and the national top-down impulse in favour of active modes of transportation have changed the perception of cycling infrastructures across Mayors. Indeed, according to Meylan, (M. Meylan, personal communication, January 6, 2020), the majority of candidates, no matter their political affiliation, have included a CS network project in their ambitions. Cycling has become a political tool to seize the growing interest of city dwellers for this mode of transportation and therefore attract (or keep) this electorate. Also, Mayors who used to be sceptical about cycling infrastructures a few years ago have now implemented some bicycle lanes in their municipality to show that they are up-to-speed with the overall dynamic of promotion of the bicycle as a mode of transportation across the metropolis, and to avoid the criticism of local cyclists' federations.

- CEOs

As shown among candidates to the upcoming municipal elections, cycling has become a (political) tool to maintain a certain image and therefore attract a part of the population which wants to be provided with cycling infrastructure to commute. A bottom-up phenomenon has also appeared for the last couple of years: CEOs of firms based in the suburbs of large cities asking explicitly the metropolitan government to implement qualitative peri-urban cycling infrastructures so that they can stay attractive to the abovementioned target group. Typically, this type of workforce used to drive a company car but now wants to ride a bicycle to work. Some CEOs have had to adapt to this shift of their candidates' transport mode, as reported by one of them: *"We can't recruit anymore, they don't want to come by car anymore"* (M. Meylan, personal communication, January 6, 2020).

Such examples of demands from the private sectors occurred for firms located between 7 and 15 km from the city-centre, which makes the argument in favour a CS networks stronger for

the metropolis government to convince Mayors of the municipalities located within these distances.

4.4.3 Potential of using CBA

The case-studies of Toulouse and Lyon show that CBA has never been used, to the best of the knowledge of the four Urban Planners interviewed, to contribute to the decision-making process regarding CS networks. The first question regarding their background experience of CBA (independently of CS-related projects) was recurrent: “Have you ever made use of CBA in any of your cycling infrastructures projects?”. The answers were a blunt “no”.

After a discussion leading me to investigate the implementation process of cycling infrastructures – and more precisely the process of convincing and mobilizing the actors – I questioned the interviewees on their opinions on the use of CBA to: 1) analyse various types of transport infrastructures (including PT, motorways, etc) and compare the NPV and IRR to the results of a CBA for potential CS networks. 2) identify more costs and benefits for the society and 3) help managing the limited budgets of metropolis governments.

The answers I collected can be grouped in basically two categories:

1. Health benefits of cycling are not convincing for neither mayors or metropolis governments since hospitalization costs and sick leaves are financed by national funds (i.e. branches of the Ministry of Health and the Ministry of Labour). According to (S. Boux de Casson, personal communication, October 16, 2019), municipalities and metropolis governments would not benefit directly from such benefits.
2. Comparing various transport options from an economic perspective is taboo (M. Meylan, personal communication, January 6, 2020). Indeed, some of the interviewees argued identifying benefits and costs of cycling would make this mode of transportation (too) competitive compared to, for instance, PT which is highly subsidized and costly. Due to the recently massive investments in PT networks, undertaking a CBA to compare the NPV and IRR of CS and PT network would be challenging the decisions made by previous governments (which could appear to be inappropriate from a public perspective).

4.4.4 Sub-conclusion

The two cases chosen to analyse the implementation of CS networks in France show how different the decision-making process and the organization of the actors can be from one metropolis to another. Also, the two CS networks projects were at different progress levels, which allowed me to investigate various stages of their implementation.

In Toulouse, the allies are locked into place and the actor-network has become stronger due to the achievements of the actors led by *Tisséo* (the coordinator of the project): the routes of the CS network are defined, round tables are organised frequently and the metropolis government has officially announced the cooperation between all the actors, the positive effects of the project on the population and the timeframe of the construction (2020 - 2030). As seen in Figure 11, the actor-network is complex, and many interactions were observed between the civil society, private actors and public entities. The metropolis government has tasked *Tisséo* to manage the ambitious project of implementing a 370 km-long network of CS, made of 13 routes.

In Lyon, the CS project is under consideration of both the technical departments of the metropolis government and the candidates to the 2020 municipal elections. As explained in this chapter, the bicycle is perceived as a political tool and CS are among the ambitions of the majority of the actors of the political network. Under the pressure of the cyclists' federations and with the growing interest of public actors for the bicycle as a mode of transportation, candidates and elected officials are now concerned with providing CS networks to the city dwellers.

The two cases show that the costs and benefits of CS networks are largely underestimated by public entities in their decision-process. Even though Urban Planners from metropolis governments, UPA and even local municipalities might be personally aware of the factors mentioned earlier in this report (i.e. the variety of costs and benefits of CS), they do not use any economic tool such as CBA to weight pros and cons of large cycling infrastructures investments. It appears that elected officials have preconceived ideas of the bicycle as a mode of transportation and are often influenced by their personnel actor-network which includes relatives and friends reporting their experiences (positive or negative) with bicycle users (M.

Meylan, personal communication, January 6, 2020). Urban Planners therefore have to convince elected officials using a set of arguments adapted to the knowledge and preconceived ideas of their audience.

In the case of Lyon, another unexpected argument against the use of any calculative devices is the human aspect of decision-making. Indeed, it appears that challenging the current transport paradigm in the actor-network of metropolitan transportation might be "taboo" and could bring new controversies. In the case of Lyon, the recent investments in PT networks are the results of years of negotiations across consecutive governments, involving large public spending. The arrival of CS networks in the established transport paradigm of the French metropolises has made the relationships between the actors unstable. The bottom-up interest for such infrastructures, combined with the top-down national voluntarism towards active modes of transport are challenging the achievements of the current metropolis government whose latest investments have shown a preference for PT. Demonstrating with a calculative device that CS networks are a viable investment could, in the current context, be controversial (M. Meylan, personal communication, January 6, 2020).

This analysis started with the preconceived idea that mobility budgets allocated by metropolitan governments had to be carefully spent across the various transport modes and that decision-making support tools were frequently used by Urban Planners to make their projects convincing to the eyes of the decision-makers. It appears that the process is biased by irrational arguments such as the decision-makers' own perceptions of the bicycle.

5. RECOMMENDATIONS

5.1Opportunity

A tool like cost-benefit analysis could allow public decision-makers from metropolises to better understand the overall potential of CS and better apprehend the benefits of an active population on the accessibility, the inclusiveness and the enjoyability of their territory. From the perspective of public health budgets, CBA could demonstrate to the national government (Ministry of Health and the Ministry of Labour) the obvious correlation between an active lifestyle involving riding a bicycle to work, and a healthier population requiring less medical care, sick leaves and treatments (Gössling et al., 2019).

"In Copenhagen, the Capital Region of Denmark has understood the imperative link to be made between health and active modes since it is responsible for both sectors. The financial link has therefore been understood for a long time and the cost and benefit estimates are therefore more elaborate than in many countries." (C. Imbert, personal communication, November 21, 2019)

Also, using CBA would allow public decision-makers from the national level to distribute the funds of the "Bicycle and Active Mobility Plan" in a transparent manner, if the results of the CBA undertaken were made public as they are in cost-benefit analysis in the capital region of Denmark (COWI for the City of Copenhagen, 2009). Finally, the use of CBA could allow social, environmental and health aspects to be taken into account in cycling infrastructure projects such as CS network, as shown in the previous chapters.

However, even in the most bicycle-friendly countries, the use of cost-benefit analysis is either controversial (Beukers et al., 2012), or still evolving. In Copenhagen, consultancies COWI then INCENTIVE have progressively upgraded their model named TERESA, in order to include more criteria in both costs and benefits and improve their precision based on the data they gathered. Based on the experience of both the Netherlands and Denmark in the use of CBA to evaluate the viability of CS, and considering that the actor-network of French CS could incorporate this knowledge easily through intermediaries (such as research papers and economic reports) and human actors (such as consultants), the implementation of a rigorous and systematic CBA methodology conceived on the latest state of the art could, I believe, make CS more appealing to elected officials.

5.2 Improved CBA

In order to compare cycling to other transport modes using CBA, the inclusion of as many relevant factors as possible and their precision are crucial. Willumsen & Roehl (2010) have demonstrated how the misevaluation of the costs of driving and cycling have led to an underestimation of benefits of cycling infrastructures, stating *"the total cost of a trip by bicycle may seem unrealistically low compared to the cost associated with a car trip"* (p. 5). Additionally, a recent comprehensive study undertaken by Gössling et al. (2019) demonstrates that *"the true cost of automobility is systematically underestimated"* (p. 72).

Because of their primary function, CS networks can be in competition with other transport modes, therefore, to make them competitive, *"CBA needs to be comprehensive and comparative, specifically in contexts where substitutable transport modes compete for space or prioritization"* (Gössling et al., 2019, p. 72). CBA is a powerful decision-making support tool that will improve when more data are included in the calculative process, that is why efforts should be made to improve the use of such a tool when assessing the viability of cycling infrastructure projects to compare various transport mode equitably (Willumsen & Roehl, 2010) and more particularly cycle superhighway networks due to their incidence on many disciplines, as explained earlier in this report.

5.3 Improved actor-network

As shown in the analysis presented of the two cases, the indispensable actors in the process of implementing CS networks, namely Tisséo for Toulouse and the metropolis government for Lyon, will need to convince and mobilize many actors and use different methods to define each actor's role and make sure they stick to it. The actor-networks will become stronger when *"reaching agreement among stakeholders on what actions are needed and how these should be elaborated."* (Van Ommeren et al., 2012, p. 8)

In the Netherlands, consultancy DECISIO argue the need of an *"increase of the awareness of the social costs and benefits of the bike over other modalities"* (Van Ommeren et al., 2012, p. 8). Raising awareness in France about these benefits will need to be made on a larger scale, to convince decision-makers of not only the environmental benefits of long-distance cycling infrastructures, but also their social and economic impact, so that coalitions among disparate bureaucratic entities can be formed. Only then can budgets repartitions be made in a rational way, supported by evidence-based arguments.

Finally, to strengthen the actor-network of CS, the design of the infrastructures and its routes could be made in co-creation with various actors, including the civil society, cyclists' federations and local politicians. Involving such human actors from the early steps of the project could enhance the involvement and reduce the risk of retraction from the actor-network.

5.4 Combination

Beukers et al. (2012) mention the findings of the European Conference of Ministers of Transport summarizing the frequent critiques made to the use of CBA, and mainly the rigidity of the assessment phase (ECMT, 2004). This report recommends not to use the results of CBA as a strict economic assessment tool but rather as a baseline to continue the analysis of the project's various options and improve them. Then, it might be helpful to use another tool to provide guidance to decision-makers on how to analyse and compare the results of CBA.

Depending on the decision-makers main concerns, cost-effectiveness analysis (CEA) could be a useful tool. In the case of cycle superhighways, a type of infrastructure which I have argued could contribute to tackling the transport poverty issues of some of the French metropolis suburbs would be appropriate in addition to CBA.

"If decision-makers are concerned about equalizing mobility-enhancing benefits, then a cost-effectiveness analysis could well be carried out, in addition to the cost–benefit analysis, in order to determine which project alternative contributes most to the goal of equalization." (Martens, 2011, p. 969)

Finally, as shown earlier, due to the competitiveness of CS with other modes of transport, the monetary results of CBA might not be sufficient to make a decision among drastically different options, therefore CEA *"can offer guidance on which of several alternative policies or projects to select if a selection is necessary. By extension, CEA can rank any set of policies, all of which might be undertaken and when there is the given that at least some of them must be undertaken."* (Lütken et al., 2013, p. 28)

6. THEORY DISCUSSION

Using an Actor-Network perspective to describe the use made of the Cost-Benefit Analysis within cycling infrastructure project was particularly appropriate to improve the framework of CBA, which, by definition "*takes human beings as a departure. Impacts on other species and nature are included from a humans perspective."* (Van Wee, 2012, p. 4) This project was an attempt to demonstrate the need to also include non-human actors, intermediaries and nature if a full-scale CBA is to be conducted to shed light on as many costs and benefits of CS as possible.

To investigate the technical implementation of CS networks across the two metropolises presented, I could also have used Techno-Institutional Complexes (TIC). This would have allowed me to identify the interconnected systems interacting with transport planning in this case and get a grasp on the mechanisms needed to implement CS networks from another perspective. New actors would have been identified. ANT and TIC are complementary. However due to the restricted time allowance of this project, ANT alone was chosen.

7. DISCUSSION

The municipal elections planned for March 2020 represent an opportunity to break away from the current mobility paradigm of both municipalities and metropolises governments. After the national government has considered the bicycle as a mode of transportation by creating a legal framework for active modes of transportation and a dedicated budget, the transport authorities will have to act according to this new vision of the bicycle as a mode of transportation and reconsider their positions when planning infrastructures and defining policies. Transport Planners and elected leaders must challenge their existing preconceived ideas and the current knowledge they have on what the bicycle can achieve as a tool to fix our cities and build sustainable ones.

The knowledge owned by the CEREMA and the Urban Planning Agencies is evolving as the visions of elected leaders and their teams are enriched with experiences from bicycle-friendly cities, testimonials, study-trips and demands from grassroots activists for better conditions to cycle. For long, this knowledge was limited and unchallenged, technical solutions and policies were meant to fit the French urban fabric, drastically influenced by the automobile industry and reshaped accordingly. The bicycle had become a guest, infrastructures were designed so as not to ‘disturb’ too much the other city dwellers, especially the motorists. The new legal budgeted framework could induce a shift in the road-use hierarchy and the mentalities that led to the current status-quo, enclosed in an outdated paradigm.

Planning sustainable cities undoubtedly involves making rational budgetary decisions and creating alignment in the decision-making process of transport infrastructures planning to promote the implementation of resilient-inclusive-sustainable infrastructures such as cycle superhighways.

8. CONCLUSION

The analysis hereby presented was aimed to address a two-fold matter: the use of cost-benefit analysis in cycling infrastructures and the development of cycle superhighways in France. The current context is reshaping the relationships between the actors, since both a legal aspect and a dedicated budget were allocated to the bicycle as a mode of transportation. The present analysis of the decision-making process and more precisely the cost-benefit analysis took place in a rapidly changing environment, making this analysis challenging and its research question relevant. Challenging because the focus here is on cycle superhighways, a type of qualitative cycling infrastructure which is fairly new to many urban planners, technical advisers and decision-makers in France. Relevant because, as the first interviews conducted showed, CBA is not (yet) used to estimate the costs and benefits of a network of CS in France, nor is it used for cycling infrastructure in general.

The first step of the data-collection process (see Figure 4) was to learn about the use of CBA in cycling infrastructure projects in both the Netherlands and Denmark. Due to the profusion of academic literature on the topic (Gössling & Choi, 2015), a selection of publications focused on relevant aspects of cycle infrastructures (and preferably CS) was made. Then, the academic findings were completed by an investigation of the implementation of Copenhagen's *Supercykelstier*. Due to the use of CBA in such a successful project and the endeavour to perfect this decision-making support tool by the City of Copenhagen (and the economic consultants mandated), the Danish context was considered as a best practice to implement CS in a rational way. The efforts to include more aspects in the calculative process (Gössling & Choi, 2015), such as sustainability, and improve the precision of the health values show the voluntarism of the Capital Region of Denmark to manage its territory efficiently while considering the interconnections of the many systems constituting not only cities but also metropolises.

Due to the decision to work with actor-network theory, the second step of the data-collection process was to get immersed in the actor-network of the bicycle urbanism world working on CS projects. The cooperation with consultancy Copenhagenize Design Co., and the participation of their Master Class in Bordeaux, France, mid-October have allowed me to interact with a variety of actors involved in the implementation of CS projects. From this moment on, a shift in the method to collect information was needed. Indeed, due to the lack of available literature on CS projects in France and the use of CBA in cycling infrastructure

projects, I had to conduct interviews with urban planners to better understand the decision-making process, which allowed me to address the issues of power, influence and knowledge across the organizations and actors involved.

Based on these two parallel steps, two opposing paradigms were observed. In Denmark, CBA has been used extensively and the actors know the limitations of such tool, they are able to combine it if necessary, with alternative decision-making tools. In France, CBA has been used to assess the viability of large transport investments but not for cycling infrastructures projects and consequently not for CS projects. Some of the urban planners interviewed have provided unexpected arguments about the irrationality of the implementation of transport infrastructures and the lack of calculative framework.

Therefore, the third and final step of this analysis was to reflect on what knowledge can be shared between these two paradigms so as to promote the implementation of CS projects in France. It appears that because of the limitations of CBA (see chapter X), and the human factors affecting the decision-making process, CBA in itself can only remain a support tool to convince and mobilize decision-makers and stakeholders of CS projects. The process of challenging the existing transport paradigm in French metropolises also requires building a strong argument in favour of the bicycle as a mode of transport across long distances. The work of consultants, urban planning agencies and the civil society in changing the mindsets of decision-makers by providing evidence-based arguments in favour of CS is therefore crucial.

This project has shown CS networks involved a variety of aspects and can address many of the challenges of today's cities. Indeed, reflecting on the implementation of CS network using CBA addresses both social, environmental and economic aspects. It is desirable that the recent voluntarism in favour of the bicycle as well as the arrival of a new generation of decision-makers require the use of decision support tools in order to address the above-mentioned aspects.

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