CBA FOR TRANSPORT PROJECTS IN SOFIA, BULGARIA

A case study of how to improve decision making process via updated CBA

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Abstract

Based on a case study of Sofia, Bulgaria this project aims to investigate the existing framework of CBA and to propose how an upgraded CBA in the examined case can improve the decision-making processes. This study is grounded on the latest knowledge about CBA in Europe, focusing on the best practices of CBA for cycling. Furthermore, by using Actor Network Theory as a theory supporting tool the project aims to open the "black box" of CBA and get better understanding of its nature.

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1. Introduction

In the last century, the world population has experienced rapid increase and this pace is expected to continue in the coming decades. More than half of the population now live in urban areas and 68% of the world population is projected to live in cities by 2050. (United nations, 2018) This sharp rise has a multitude of side effects to the urban environment in our cities.

Urban growth and transport are deeply related issues. Transport plays a vital role in urban development. Urban and population growth requires increase in the travel demand. Cities are becoming denser and more congested than ever before, which leads to bad air quality, noise pollution, negative environmental impacts and so on. Most of the traffic related issues is rooted in accelerating of private motorizes vehicle usage. In many cities the infrastructure is not planned to accommodate the number of vehicles occupying the streets. Therefore, the car became one of the main problems in cities for this century. (Erznoznik et.al., 2014)

According to Noah Harari (2016), in 2010 the number of private cars in the world exceeded one billion and it has kept rising. Although, cars are linked to increase in the economy, they pollute the planet and waste enormous resources, requesting wider roads and parking space. People have become used to the convenience of private cars, so it is hard to convince them to shift to other more sustainable transport modes. However, as Harari states, people want mobility rather than private cars. Therefore, the purpose of our transport systems should be to provide cheap and efficient mobility within the urban areas. (Harari, 2016),

Cities which are dependent on cars have many issues related to the costs of sprawl and to the costs of transport, including the oil vulnerability issues the automobile dependence has numerous of social and environmental impacts. Although, there is an assumption that economic outcomes are favored by the car, the externalities related to cars should be considered. New transport studies show a different perspective focusing on the worsening the social and economic impacts due to cars. These negative impacts include congestions, climate change, air and noise pollution, list of health impacts, like obesity heart diseases, etc. (Newman & Kenworthy, 2015).

All above mentioned leads to the need of shifting the current transport paradigm. Transport is one of the most challenging political, environmental, and social problems in the world today. The necessary of implementing more sustainable means of transport across the world is crucial. In previous years, the cities around the world have been planned with the assumption that the primary method of transport will be the private automobile. However, in recent years, more sustainable forms of transport are taking momentum. Still there is a significant variation among countries and cities due to preferences and priorities among both public administration and citizens. (Erznoznik, 2014)

Moreover, due to financial limitations many cities, face difficulties in implementing new transport systems. In front of the need of transforming the transport infrastructure in favor of public transportation and cycling, politicians need economic decision supporting tools in order to justify the investment in transport projects. Tools like CBA can play an essential role in the decision-making processes. Although, the use of CBA is widespread across Europe, there are few examples of CBA for cycling (Gossling, 2015).

The paper discusses the use of CBA of transport projects looking through the lenses of ANT. The aim of this report is to indicate the weaknesses of the commonly used CBA framework in Europe. The report examines a case of Sofia, Bulgaria, the existing CBA within this case and how its use could be improved. Looking at the best practices across Europe, the paper seeks to show how the CBA could be applied in order to show the benefits of cycling in urban areas. Focusing on Sofia and realizing the need of implementing new transport policies within the case, the report undertakes the following research question and accompanying sub-questions.

RQ: How can an upgraded CBA improve decision making and promote the development of cycling infrastructure in Sofia?

Analysis 1: What are the existing CBA for transport projects within the case of Sofia and what parameters do they include?
Analysis 2: Who is involved and what is the sequence of decision processes regarding transport infrastructure in Sofia and the role of CBA?

2. Problem formulation

Today's cities experience challenges in terms of congestion, lack of space, growing populations, air quality, noise, livability, social inclusion, health, economic development, and creation of jobs. The citizens and businesses are demanding greener, safer and healthier places to live and work. The mobility of people and goods is one of the most important elements of urban planning, which characterizes urban space and the way it functions. People and their goods need to move from point to point cheap, easy, smart and clean. (Kuster, 2019).

Throughout the last century, personal transport has been dominated by private vehicles, mainly with internal combustion engines. This has given citizens freedom in terms of mobility. On the other hand, that "convenience" has caused a number of negative impacts. The mass adoption of private cars in cities has led to congestion, negative environmental impact, air and noise pollution, issues with human health and safety. Moreover, all these factors have led to reduced livability and social inclusion (European commission, 2019). "A livable city is one that serves the needs of people and environment." (Ween, 2017) Firstly, a livable city must be socially healthy, it must respect the environment and to provide equality for its citizens. That means that cities should require equal access through good transport options. Moreover, by creating active travel options, we attract human activity and social interaction. From environmental point of view, a livable city is in harmony with the environment if its transport systems are clear, low carbon and space efficient. In that sense, motorized traffic is not an adequate transport mode in livable cities. That is why contemporary cities should focus on replacing private cars with other active transport modes like cycling and walking. (Ween, 2017) The livability of cities is determined, to a large extent, by the city's transportation system as this can be a solution to a number of the challenges mentioned above. That is why the implementation of the future mobility systems in cities is crucial for economic, environmental and social aspects.

2.1 The cost of cars

The increase of motorized traffic has various negative consequences for people in the expanding cities. The devotion to cars is related to several perceptions that it has economic benefits. Also, the car in many countries became a symbol of personal status. However motorized private transport is accompanied with a lot of costs. Transport systems dominated by motorized traffic have been a major contributor to climate change through release of

harmful emissions. According to European Parliament transport is responsible for nearly 30% of the EU's total CO2 emissions, of which 72% comes from road transportation, as in that number 60.7% are dedicated to cars. (European Parliament, 2019)

According to Global Energy Assessment published in 2012 transport requires 27% of the final global energy use (Johanson, et.al, 2012). The European Environment Agency (2003) estimated, that the external cost of transport equals 8% of GDP in the EU including Norway and Switzerland. These costs are calculated to be more than €500 billion. Cars contributes to 58% of this total cost, including accidents, noise, air pollution, climate change, and related environmental impacts. (European Commission, 2011). Moreover, it causes numerous issues to humans. As mentioned above cars are the origin for congestion and therefore the main cause for air and noise pollution, which leads to numerous health issues like obesity, heart diseases, nervous system diseases, etc. Motorized traffic is responsible for 16% of deaths worldwide due to bad air quality, which equals to €4,13 trillion, representing 6% of world GDP. Moreover, according the World Health Organization (WHO), the cost of traffic deaths and injuries is calculated at 3% of global GDP. (WHO, 2015) Additionally, car dominance leads to social inequality, as it makes it impossible for some people to move safe and independently in cities. All these negative impacts lead to the need of re-designing cities and favoring more sustainable transport modes.

2.2 Bicycle as a good alternative to car

Cycling as an active mode of transport has various benefits compared to motorized vehicles. Firstly, it does not contribute to CO2 or other emissions. It takes less space both road and parking. Also, it assigns to well-being and health of citizens, regardless accidents, and considerable health benefits such as longer and healthier lives with improved mental health. Moreover, cycling is one of the least expensive transport modes. Due to these positive impacts, cycling is currently put on the top of European agendas in countries like the Netherlands, France, Austria, Slovenia etc. (Colville-Andersen, 2018). However, they are many cities across Europe that are failing at the implementation of more sustainable transport systems including the active transport modes. (UNDESA. 2012)

Cycling as an active transport mode already express positive contribution to society and environment. These benefits include ease congestions, contribution to carbon reduction, improving the air quality, benefits to individual health, economic efficiency and so on.

Realizing the importance of showing the benefits of cycling in monetary terms the European Cyclists' Federation prepared a report on economic benefits of cycling in the EU which are lately updated in 2016 (ECF, 2016) The benefits of cycling are calculated to be €513.19 billion. This number exceeds more than eight times Bulgarian annual GDP, which is €63.13 billion for 2018 (The world bank, 2019).

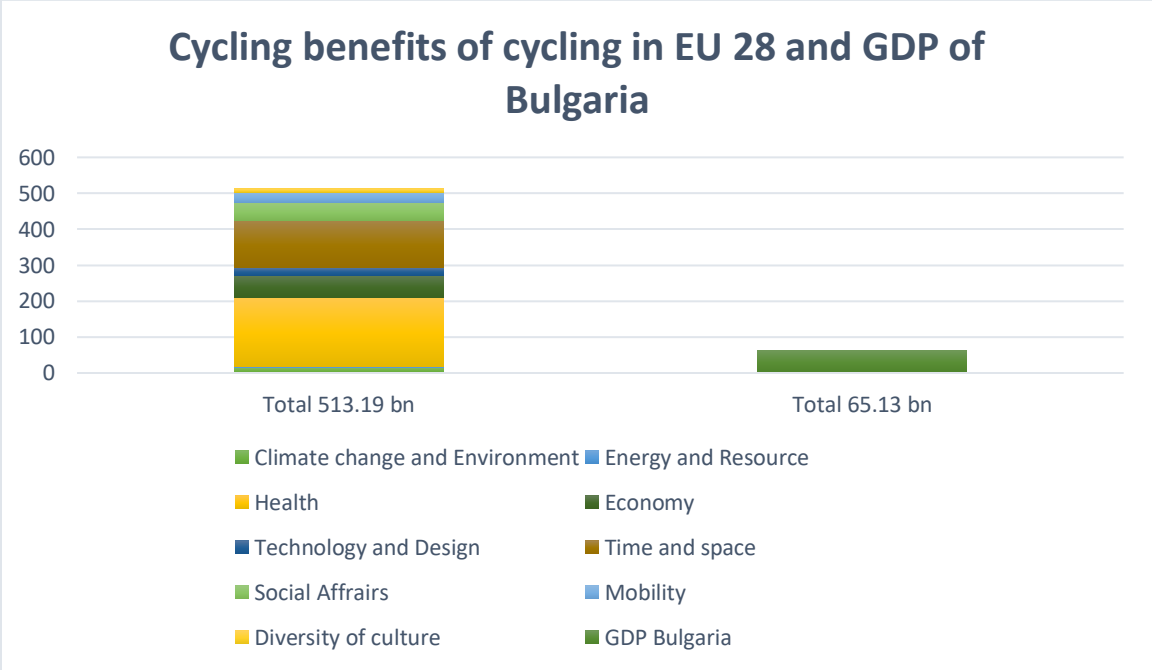


Figure 1: Comparison between the cycling benefits of cycling in EU 28 and GDP of Bulgaria for 2018 (ECF, 2016)

2.3 Best practices around the world

Countries like Denmark and The Netherlands are the leading in pro-bike culture and are good examples of well-integrated infrastructure and good policy in promoting biking as a daily transport mode. They can be used as a source of data and approach for countries that make the first steps into cycling. That is why throughout this report

Transport systems need a significant change in order to be aligned with the UN Sustainable Development Goals. Across Europe and beyond, cycling and walking are becoming more common and many cities realize the benefits of such active transport modes. Ideally, these modes can replace cars in cases of short trips. It is proven that the percentage of people

biking increases where safe separated cycling tracks are built, and trips are short and pleasant (Gossling, 2015) However, these conditions are hard to be achieved due to the present transport system mainly dominated by car traffic, due to the perceived traffic dangers, exposure to bad air conditions and noise pollution. Therefore, cities need to redesign their urban environments, to create proper conditions where cycling could evolve. Namely the infrastructure should be safe, fast, cohesive attractive and comfortable. However, the most common issue to urban redesign, apart from the political will, is the cost. That means that tools which evaluate direct and external costs are from critical importance in order to guide decision making in such transport projects.

3. Case of Sofia

3.1 Geographical information

Sofia is Bulgaria's capital and largest city. Founded thousands of years ago, today the city continues to develop as the country's cultural, political and economic center. At present, the city has a population of 1,250,000 (United Nations, 2019). According to the National Statistical Institute NSI (National Statistical Institute) every 5th Bulgarian lives in the capital and together with the temporary residents, students and seasonal workers the population exceeds 1.500,000 (NSI, 2017). The capital has a key role in the economic development of the country. Forty percent of the country GDP is produced in Sofia and 25 percent of the country's workforce belongs to the capital.

Due to the rapid growth of the population in Sofia as it increased by more than 25000 since 2015, the city experiences issues regarding urban development, especially with respect to traffic. (NSI, 2017)

3.2 Structure of Sofia – street network

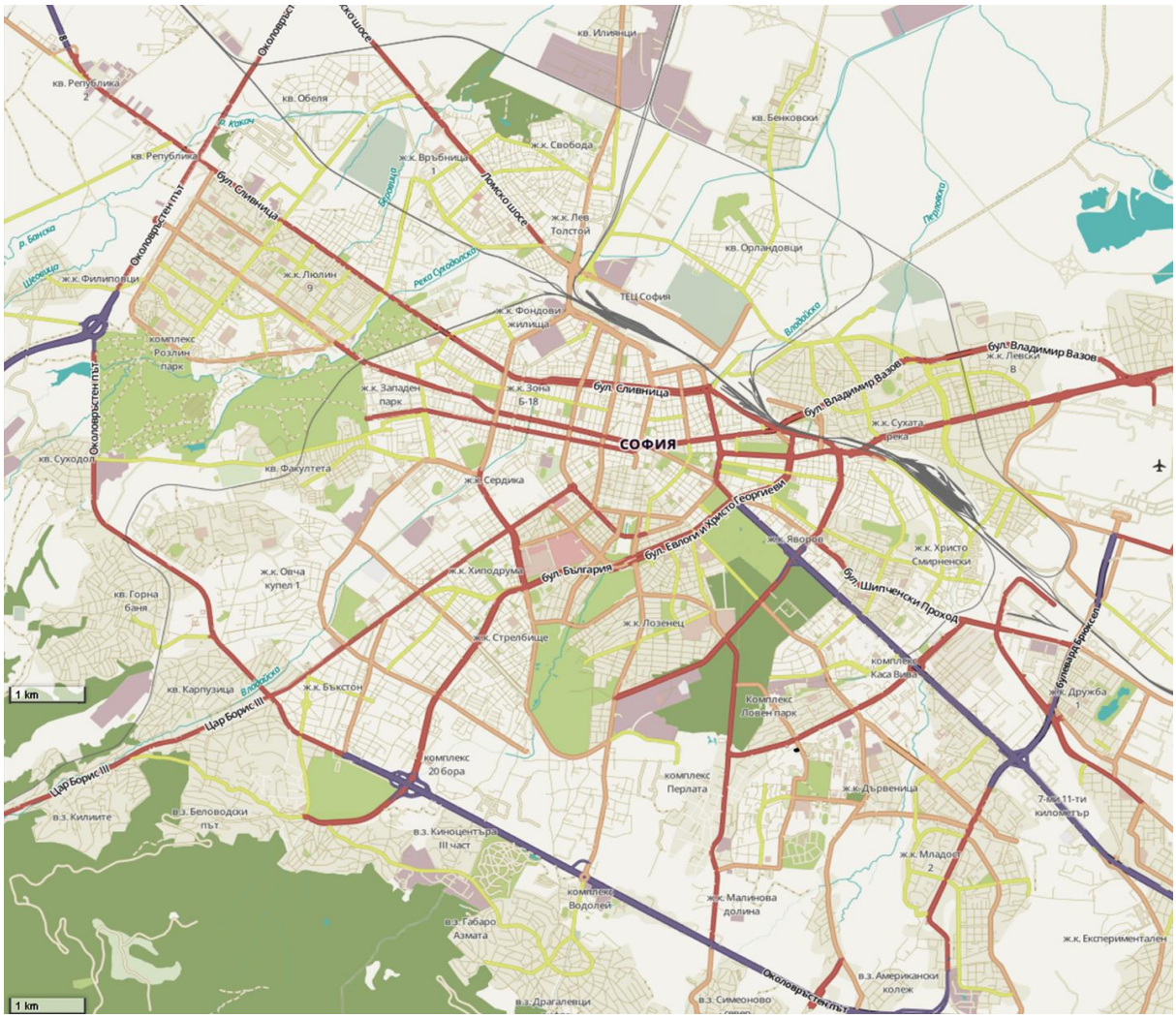


Figure 2: Structure of Sofia – street network

The structure of the street network is radial - circular with an orthogonal secondary network in the central city part. However, the street network is under-developed, as it is not entirely completed and the streets in many neighborhoods are in bad condition, e.g. bad pavement. In practice the innermost and the outmost rings are entirely developed and complete. The intermediate rings and tangents are partially missing, and some parts are entirely absent of the street network that is underlined in the Urban Master Plan for Sofia. (SUMP, 2019)
The macro structure of Sofia can be specified as a compact city with radial – circular structure. Since Sofia became the capital of Bulgaria in 1987, the city is growing concentric around its historical core. With the expansion of the city, there are several planned and partly

implemented subrings, which connect the new periphery neighborhoods. The main transport axes follow the historical traffic directions, namely southeast, southwest, northeast, northwest and north.

Following the social structure of the city, several concentric zones could be distinguished. The Central core, which is the territory within the first city ring, which concurs with the historical center of the city. The central city part is the territory which reaches the second city ring. The inner city is situated around the central city part to the third city ring, which back in the days was rail ring. This part of the city was built mainly between the two world wars and played mainly an industrial role. Today most of this area is reconstructed and transformed into residential and business zones. The periphery of Sofia is located between the third and the fourth city ring (the city Bypass). In this area are situated the most populated residential zones. According to data from SUMP in this zone are situated neighborhoods which after the 90's was subject to intensive construction with an absence of adequate street networks and public services. The zones outside the compact part of the city are the outside city area. Some of the areas there have the status of neighborhood and others are independent settlements. (SUMP. 2019)

The street typologies vary from heavily trafficked main roads to small human scale streets, from asphalt to pavements.

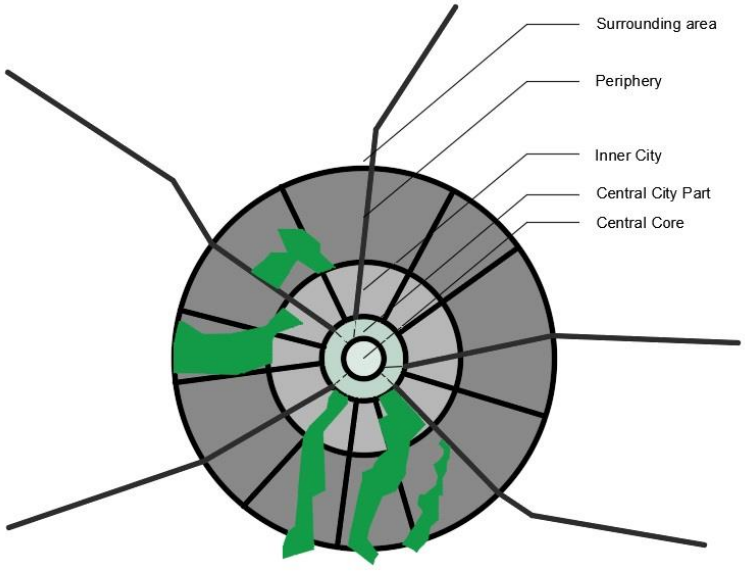


Figure 3: Structure of Sofia – An idealized model (SUMP, 2019)

3.3 Administrative structure of Sofia

Sofia Municipality is an administrative-territorial unit, with status of region. The municipality is divided into 24 districts. In Bulgaria Municipalities are legal entities, which own property – public and private and its own budget. The mayor if municipality is an executive body. She manages all the administrative activities of the Municipality. Moreover, the mayor of the city is responsible for public order, budget implementation, and operation of long-term programs. The Municipal management is structured in functional and sectoral departments and groups, governed by Deputy Mayors.

The municipal authorities define and implement their policy, resolve problems of local nature related to the economy, spatial planning, traffic safety, environment, healthcare, social, cultural, educational, community related activities, disposals and management of municipality property, etc. (Sofia Municipality, n/d)

3.4 Current traffic situation

Since the 1960's, the principles of urban planning and development have been determined by the predominant modernization approach and the specific socio-economic environment. Motorized transport has been given priority over other transport modes and the urban viability, such as open green spaces and zones for leisure and relax has been put in the background. The response to the trend of increasing motorization through the continuous increase of the capacity of the street network has led to even greater demand, known as induced demand (Loop, 2015). Although the number of passenger cars in Sofia was lower than the Western European countries, following their example Sofia focused on the developments in favor of cars. However, is it now changing as European politics regarding transport have focused on more sustainable transport solutions. (SUMP, 2019)

According to data from the SUMP for Sofia, every citizen in the capital spends average 64 minutes in travelling to work or school every day. Moreover, the average resident of Sofia spends 8 percent of her income for transport. (SUMP, 2019)

Although, Sofia is moving forward in becoming more sustainable by creating and adopting strategies and plans, the city is still one of the least livable capitals across Europe, ranked as one of the last in quality of living according European commission. As the city is one of the most polluted, the income of citizens is the lowest in European Union and other factors that will be posed later in the report. (European Commission, 2016)

In Sofia and general in Bulgaria, motorized transportation has increased dramatically throughout the last three decades. This has led to congestion, negative environmental impact, increase in noise levels and occupied public spaces by cars due to bad parking management (SUMP, 2019). Transportation is one of the main origins for CO2 emissions. Some of the main issues in Sofia Municipality are the increasing levels of harmful emissions, pollution and noise levels.

The mobility policy of Sofia mainly works with public transportation and motorized modes of transport. The modal split of 2017 tells that 37,1% of trips are by public transport, 31,4% are by cars and other motorized vehicles and 29,7% are pedestrians. Cycling takes a marginal role only with 1,8%. In addition, the audit group who made a traffic evaluation in the capital concluded that there is a lack of catering for the needs and opportunities of active transport modes, some voice that public space is mainly dedicated to cars (ParkPAD, 2019) Additionally, the total length of bike lanes is barely 55,5 km in the capital (SUMP, 2019).

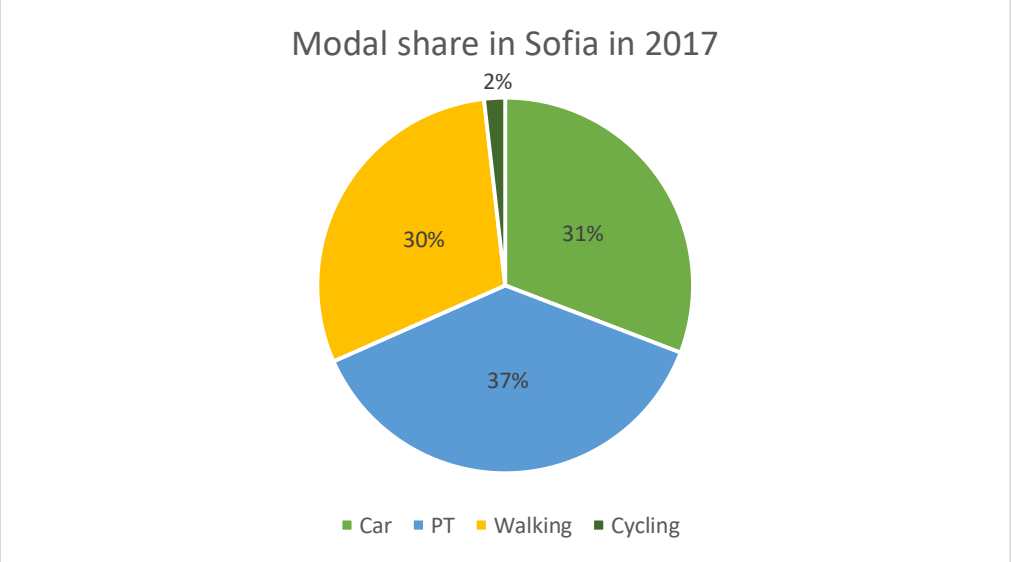


Figure 4: Modal share in Sofia (SUMP, 2019)

3.5 Problems and issues in the case of Sofia

3.5.1 Car traffic

The transportation system in Sofia is under continuous pressure by the increasing levels of motorized vehicles and excessive use of private cars with enormous expenses for the economy and health of people. The levels of motorization are above European levels. As showed on figure 4, the percentage of people that travel by car daily is above 30% with decreasing levels

in the usage of public transport, walking and biking. Another issue regarding the increase of the motorized traffic is the fact that the car became a status symbol for people. It is seen as a means of convenient transport mode, without limitation in the time and place.
Compared to most of the Western countries where the street network is developed, this is not the case in Sofia. The structure of the primary street network is underdeveloped as important parts of the ring structure are missing. This leads to overloading of the existing network and concentration of traffic in some main transport arteries and furthermore to congestion and serious increase in the greenhouse emissions. (SUMP, 2019)

3.5.2 Parking

Moreover, in the capital, the space for car parking increases 2 % every year on average. The parking is a problem not only in the central parts of the city but in the outside areas as well, especially in recently built residential neighborhoods. In some areas free parking on the streets is allowed and the increase of private cars in the capital causes issues related to the normal functionality of the street network. Additionally, many people use prohibited or unregulated places outside the parking areas (sidewalks, green areas, street lanes, parks, etc.). This creates difficulties for all road users. The area dedicated for paid parking in the capital is 222 m2. (Vision for Sofia, 2019)

3.5.3 Air Pollution

Despite some ambivalently optimistic signs, Sofia remains one of Europe's most polluted capitals – a problem made worse mostly by the slow reaction of the city's institutions.
Air pollution in Sofia, like in many Bulgarian cities such as Pernik, Burgas, Plovdiv, and Ruse, is a problem that goes way back. In recent years, several studies by the European Environment Agency have constantly placed Bulgaria at the top of the critical ranking of countries with the worst air quality, while Sofia has repeatedly earned the title of most polluted EU capital.
"A serious situation, certified in April 2017 by a ruling by the European Court of Justice (ECJ), which sentenced Bulgaria for the systematic violation of air quality standards" (Martino, 2019). The ruling, although not accompanied by financial sanctions, has given more and more voice to those who, in Bulgaria and especially in Sofia, criticize the low institutional determination of facing the situation. (Martino, 2019)
There are various factors that make Sofia so vulnerable to air pollution. Some are geographic: like many Balkan cities, the Bulgarian capital occupies a plateau surrounded by high mountains – the Vitosha massif in the south, Balkan Mountains to the north. An unfortunate

position, especially in the winter days marked by fog and thermal inversion, with the following stagnation of the air. (Martino, 2019)

However, the basic causes are not linked mostly to nature, but to human activity. One of the main issues is increasing traffic, mainly caused by private cars. In Sofia, a city now inhabited by over 1, 250,000 people, there are more than 550-600 cars per 1,000 inhabitants, in other words 60% of people in the capital own a car (Martino, 2019). Compared to Copenhagen, that number is 29% (The City of Copenhagen, 2011). That number includes an old fleet of cars, largely consisting of polluting diesel engines. According to Eurostat, Bulgarians drive the oldest cars in the EU. In 2017, for example, almost half of the vehicles circulating in Bulgaria were at least 20 years old – a situation also caused by policies that make it relatively convenient to buy old vehicles, therefore inappropriate for the ecological standards. (Martino, 2019)

The transportation system in Sofia is under continuous pressure by the increasing levels of motorized vehicles and excessive use of private cars with enormous expenses for the economy and health of people. As mentioned, the percentage of people that travel by car daily is above 30% with decreasing levels in the usage of public transport, walking and biking. (SUMP, 2019)

3.5.4 Noise pollution

According to data from Vision for Sofia (2019) 88% of the points where the noise levels are indicated were above the norms. Transportation in the capital is the main cause for noise pollution, especially the car traffic. The traffic situation in Sofia makes noise levels extremely high which creates unpleasant environments for social interactions and activities. The noise and air pollution lead to negative impact to the health of people in the areas with high levels of traffic. For example, some of the main streets are above 75dB. For instance, the noise made by a vacuum machine is 70 dB and the continuous exposure to noises above 85dB leads to hearing damages. (Gehl, 2017)

3.5.5 Accidents

The overloading of the street network, due to increasing number of cars, in addition to the poor pavement conditions, inadequate organization of crossroads and lack of control of compliance of the rules, leads to road accidents (SUMP, 2019). According to NSI the number of injured in traffic accidents in Sofia in 2018 was 42 and the number of deaths was 238. (NSI, 2018)

3.6 Plans and strategies in the Development of Sustainable Urban Mobility in Sofia

As mentioned above in section 3.4 (Current traffic situation), Sofia is moving forward to become more sustainable by meeting the transport needs of citizens in a way that is least

harmful to the environment and keeping Sofia accessible and safe, which requires a new strategy for sustainable mobility. So far in Sofia's context, the most recent and structured plan that focused on Mobility is SUMP – Sustainable Urban Mobility Plan.
This plan is linked and prepared parallel to other strategic documents developed for Sofia with regard to the long-term development in Sofia.

- Vision for Sofia - The "Long term development strategy for Sofia and the region" is an initiative of Sofia Municipality. Its goal is to achieve a shared idea about the future of Sofia and the steps necessary to get there. It is a long-term strategy for the development of Sofia Municipality and suburban territories up to 2050. This strategy is initiated by Sofia Municipality. The idea was initiated in 2016 by a network of architects, urban planners, and experts from different sectors during informal meetings. In 2017 Sofia Municipality council decided to assign the establishment Vision for Sofia. The chief architect of Sofia is responsible for the process of forming a team which creates the document. The enterprise that is hired to establish the strategy is Sofproekt.
  The Vision is being shaped by facilitating involvement and stimulating informed decision making. The former means involving all interest groups from the very beginning in the decision-making process: public administration, NGOs, investors, researchers, experts, entrepreneurs, and citizens. The latter means structuring the decision-making process on data analysis that covers all aspects of city life. The result is to be a shared idea of a common future of the city, which has been developed through an informed dialogue and a resilient system of interaction. (Vision for Sofia, 2019)

- Green Sofia is an initiative launched by the Mayor of Sofia Municipality and Sofia Development association. The aim of the project was to streamline and coordinate all policies regarding sustainable development in Sofia. (Sofia Municipality, n/d)

- Sofia - A city for people - Gehl Architects - is a pilot project of Sofia Municipality for the study and analysis of public spaces in the city center according to methodology proposed by Gehl Architects. The project is a part of Municipality Chief Architect aimed at focusing on policies related to development of spaces for pedestrians and cyclists with limited car traffic and shift to a more human-centered urban environment. (Sofia Municipality, n/d)

3.7 Status quo of cycling in Sofia

3.7.1 Bike infrastructure

The total length of the bicycle network in Sofia in 2018 was 55.5 km, meaning the density of the bike infrastructure is barely 0.22km/km2. There is no precise data regarding the connectivity of bike paths, there is lack of bike infrastructure in intersections, even on roads with existing bike lanes (Vision for Sofia, 2019). There are insufficient complementary elements of the bicycle infrastructure - bicycle stands and parking areas. Another problem with cycling infrastructure is the lack of opportunities for connecting with public transport. Bikes in the subway are currently allowed under certain conditions - on Saturdays and Sundays and after 21 on weekdays and at the price of a regular ticket. The new regulation permits the boarding of bikes also in buses but only if there are conditions for it - the vehicles will be equipped with flatbeds or bicycles. As of the beginning of 2019, there were already ten buses with flatbeds, serving the lines to Vitosha (SUMP. 2019)

Some key issues regarding bike transport in Sofia

- lack of integrated and cohesive bike infrastructure
- many conflict zones with cars
- lack of complementary bike infrastructure like bike parking
- citizens perception that bikes are only for sport and leisure
- limited opportunities to combine bike with public transport
- lack of bike mobility share system

Despite the low share of bikes in Sofia, the city has great potential to develop this transport mode because it is a dense and compact city, with a prepossessing climate giving the opportunity to spend most of the time outside. In the following image a comparison in areas and density of Sofia and Copenhagen is illustrated. Denmark. (Madsen, 2019)

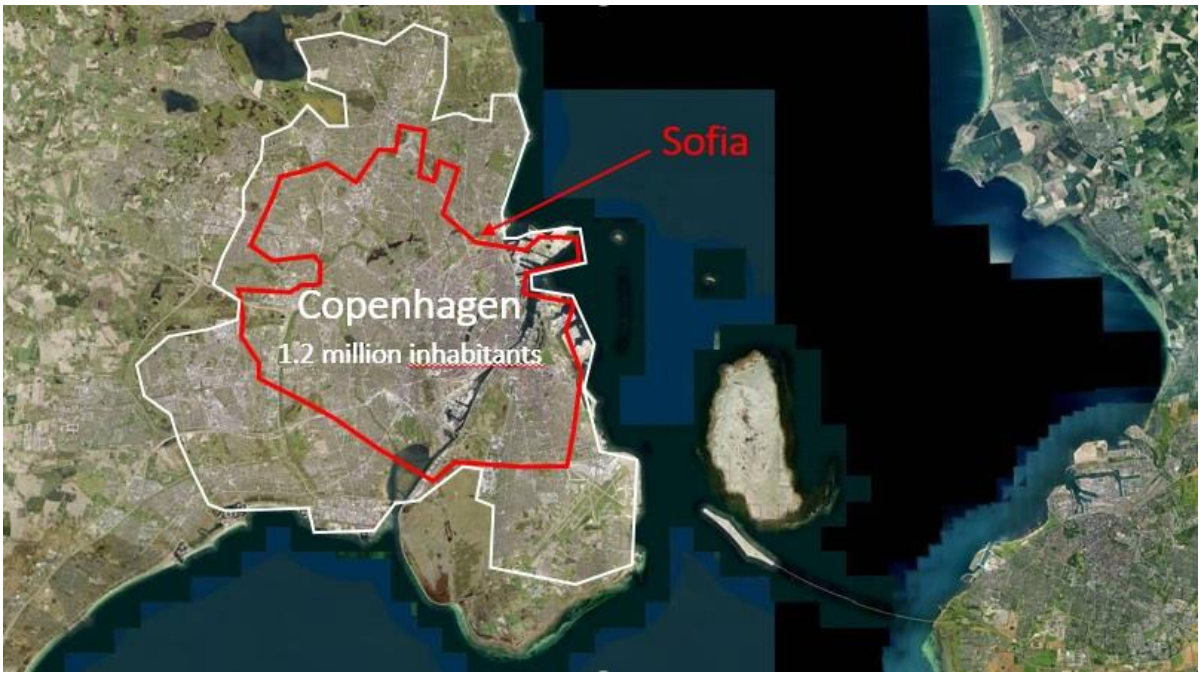


Figure 5: Comparison of the dense and area of Sofia, Bulgaria and Copenhagen, Denmark (Madsen, 2019)

According to the Sustainable Urban Mobility Plan, Sofia Municipality is planning to build bicycle routes in the central city area and other areas of the city in order to link existing bike lanes and networking, especially in the city center where the bicycle rental system will be operational. However, the exact plan is not clear and did not give explicit information of the targets and methods which these plans will be implemented. Moreover, the plan mentions that it is very important to quickly launch the system for shared bicycles, which has already started according to the data from SUMP. The practice in other cities shows that shared bicycle systems provide a major boost to the development of the bicycle movement - they provide the opportunity to move tourists and guests to the city, people who do not own a bicycle, and provides impulsive solutions for cycling. The system should also include electric bicycles, scooters and other personal electric vehicles, making it even more attractive and further expanding its users.

In the following image an idealized model of the main bicycle routes is illustrated

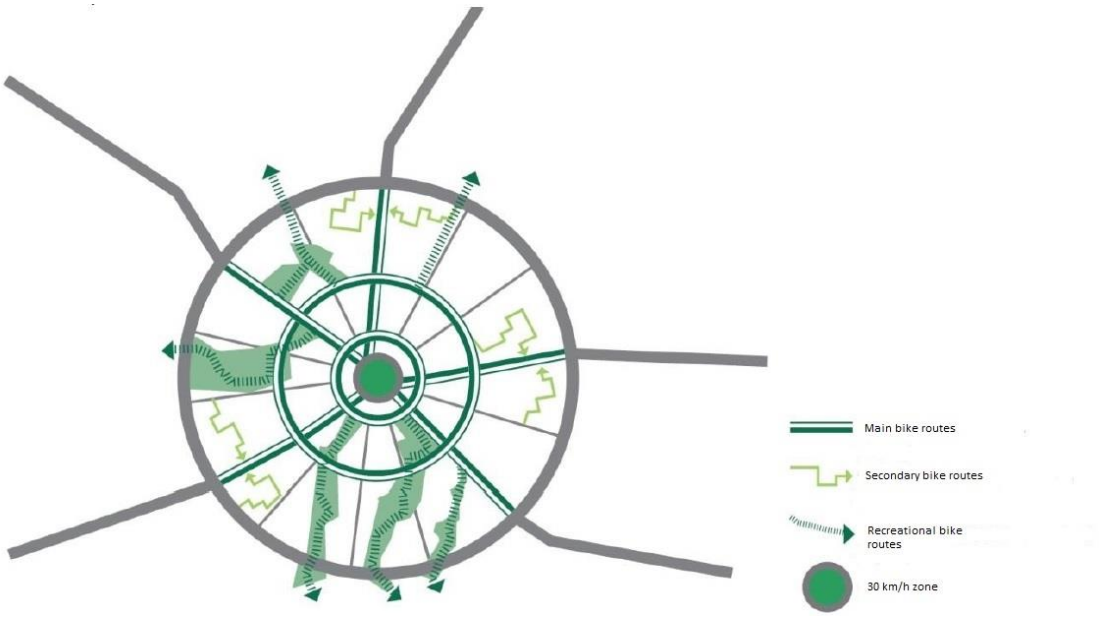


Figure 6: An idealized model of the planned bicycle routes in Sofia (SUMP, 2019)

3.7.2 Politics and organizations related to cycling in Sofia

The development of integrated, safe, and cohesive bike infrastructure is part of the above-mentioned strategies and plans for Sofia Municipality. However, there is no specific strategy focused on cycling, neither on national nor regional level. (Petrova, 2020)

As mentioned above in section 3.4 (Current traffic situation), the bike share in the capital in daily transport is merely 2%. According to the data from the Vision for Sofia (2019), the Municipality goal was to make the cycling 10% of the mobility share by the end of 2019 (Vision for Sofia, 2019). In order to reach that goal, the minimum number of kilometers of bike lanes that should be realized until 2028 is 418 km. In addition, the Municipality aims to create bike infrastructure on 80% of the existing intersections in order to make cycling safer. Nonetheless, it is worth mentioning that during 2018 the number of fatalities caused by cyclists was zero. (Vision for Sofia, 2019)

In general, the leading actors which promote cycling in Sofia Bulgaria are NGOs. In Sofia, the leading NGO which aims to increase the number of cyclists in the capital is Veloevolution. Their main objective is to represent cyclists, their opinions and interests in front of the society and public authorities. Moreover, the organization creates the opportunity for dialogues between citizens, other NGOs, businesses, media and institutions in order to optimize the transport network in favor of active transport modes. In that sense they are part of the process

of creating legal conditions for cycling. The NGO takes an active role in the development of the strategies and plans regarding sustainable mobility in the capital.

4. CBA

This section provides an overview of the defining elements within a CBA, how it works and its role in decision making. Moreover, it will introduce a CBA's role in transport projects nowadays and will reveal more information about CBA that include cycling.

CBA is a method for evaluating the socio-economic impacts of projects such external costs and benefits. In general, CBA is made to estimate costs and benefits in order to make a reasonable conclusion on net benefits – "value for money". The CBA methodology is built on early welfare economic theory, which aim is to achieve "efficient allocation of resources and maximize public benefits for general social welfare" (Ustaulglu, 2019). This tool lists and quantifies the impacts that can be assessed in monetary terms, allowing comparison. All the effects that are likely to occur are converted to currency for some time span – hour, day, year, and then an evaluation for the whole period is made to calculate the total costs and benefits. After a monetary value exists, the CBA can give indicators like benefits to cost ratio (costs minus benefits) and the return of the investments. Also, CBA is used to compare different alternatives in proposed policies options. Although, it is usually difficult to know what the best alternative would be, the idea can be operationalized by evaluating many alternatives and ranking them. (Wee, 2015)

4.1 CBA in transport projects

Cost benefit analysis (CBA) can be used to assess transport projects. To date, CBA has been mainly used in projects of highways, rail infrastructure, air, or marine transport infrastructure. The general CBA guidelines are directly applicable to any transport project. The use of Cost benefit analysis in project assessments is widespread in most public spending. CBA is considered as a decision-making support tool. The cost benefit analysis gives a monetary value to both the positive and negative effects, namely benefits and costs. CBA also allows not only to calculate but to recognize the various impacts of certain project. (European Commission, 2014)

4.2 Methodology of CBA

CBA framework needs to consider two key aspects. Firstly, which parameters to be included in calculations, and second it must include justified unit costs. The current transport system is the basis of the assessment. (European Commission, 2014)

According to European Commission guidelines a standard CBA is structured in seven steps, which will briefly be introduced in the following chapter.

1.Description of the context

According to the European Commission the objectives of any transport project should be consistent with the tutorial context of the region or country where the project is implemented. Three main assumptions should be considered before preparing a CBA. First the socio-economic trends should be presented. Then the political, institutional, and regulatory framework should be clear. And last, detailed information of the existing transport infrastructure and services should be provided.

2.Definition of objectives

The socio-economic objectives of transport projects are generally related to the improvement in travel conditions for passengers and goods, as well as improvements in both the quality of the environment and the well-being of the population served.

According to the European Commission the main objectives considered in transport projects are:

- Reduction of congestion within a network
- Improvement of the reliability and safety of a network
- Minimization of GHG emissions, pollution, and limitation of the environmental impact (important examples are projects supporting the shift from individual, i.e. cars, to collective transport).
- adjustment to EU standards and completion of missing links or poorly linked networks: transport networks have often been created on a national and/or regional basis, which may no longer meet the transport requirements of the single market (this is mainly the case with railways);
- improvement of accessibility in peripheral areas or regions.

(European Commission, 2014)

3.dentification of the project

To identify the new infrastructure development, it is important first to state its functions which should be linked with the investment objectives. It should be stated whether the project is a brand-new implementation, extension, or a link to a larger construction. And a list of all physical implementation should be presented.

4.Forecasting traffic volume

Within any transport project it is important to be familiar with the sensitivity of traffic and be aware that many factors are variable. When creating a CBA for transport investments, the demographic and socio-economic changes should be considered. Also, factors like industrial and logistic structures, capacity and spatial changes should be forecasted. And not least the changes in traffic management policies should be taken on account.

Usually in this step of the preparation of CBA for transport infrastructure, traffic modeling is required. This modelling enables the simulation of the future traffic distribution and therefore provides information of how the trips will respond and alter over time and also following the transport supplies and demand.

5.Option analysis

In this step, usually the suggested approach is to use a Multilevel-Criteria Analysis to supplement and compare the results of the CBA. The other option analysis and their benefits and drawbacks will be discussed more explicitly in chapter 9 (Discussion)

6.Financial analysis

In this analysis are considered investment costs, operation and maintenance costs and revenue projections.

7.Economic analysis

In transport projects the main direct benefits are measured by the change measurable factors but also, CBA should generate "non-market impacts" related to safety and the environment that need to be evaluated. In the following table the typical parameters that are included and evaluated are presented:

Parameter	Valuation method
Travel time savings	- Stated preferences

	- Revealed preferences (multi-purpose household/business surveys) - Cost saving approach
Vehicle operation costs	-Market value
Operation costs of carriers	-Market value
Accident savings	- Stated preferences - Revealed preferences (hedonic wage method) - Human capital approach
Noise emissions	WTP//WTA compensation - Hedonic price method
Air pollution	- Shadow price of air pollutants
GHG emissions	- Shadow price of GHG emissions

Table 1: Parameters included in European Commission Guidelines for CBA for transport projects and valuation methods (European Commission, 2014)

These are the commonly considered basis requirements for CBA. However, they do not represent all the externalities that transport represents. (European Commission, 2014) However, the most important indicators that can show whether one project is economically feasible or not are Economic Net Present Value (ENPV) the Cost Benefit Ratio CBR) and the NPV. The ENPV represents the difference between the total social benefits and costs. The CBR gives the Value of the Benefits divided by the Current Cost of the Proposal (European Commission, 2014) Net Present Value (NPV) represents the costs and benefits that occur in different years. (European Commission, 2014)

8.Risk assessment

Considering the criticality of some factors, it is advisable to carry out a sensitivity analysis of the money values assigned to the goods without any market, especially values of time saving and accidents. In transport projects very often the value of time savings can represent more than

70 % of all benefits. Other sensitivity tests may be focused on investment and operating costs or on the expected demand, in particular the generated traffic. (European Commission, 2014)

4. 3 CBA for cycling

As mentioned above, CBA is not often used to evaluate cycling policies, especially in countries where the bike share is lower. Although, there is not enough academic literature regarding CBA for cycling, there already exist works which assess the effects of cycling policies. Moreover, some literature on assessing the cost and benefit of cycling projects have been published, even though they are not complete. A narrative of the most relevant examples be discussed in chapter 5 (State of the ART). (Wee, 2015)

Bert van Wee (2015) suggests several reasons for lack of CBA for cycling. Firstly, it is because it is harder to give a monetary value for the effects that cycling interventions provide. The commonly used methodology is less developed for projects for cycling compared to other transport projects. Moreover, the data needed for the analysis is usually limited. Another reason is that some facilities for non-motorized transport mode are relatively cheap and that sometimes is the reason for such projects to be neglected and not considered as reliable. Subsidies are often for expensive infrastructure projects and non-motorized transport is ignored due to lack of powerful stakeholders in contrast to non-governmental and small organizations which support cycling. One more motive is that cycling policies are in general considered as a task of local municipalities, but as mentioned CBA is usually applied for large-scale projects with national importance.

However, all reviewed CBA for cycling showed a positive net benefit ratio. In most cases the benefits are due to health benefits. On the other hand, the component of travel time savings usually gives the large portion of benefits for any transport project different than cycling. According to Bert van Wee (2015) in the general for infrastructure policies where cycling is not something new, the cost of cycling is commonly quite known. For counties, where there is a lack of previous work on the subject of such policies, the experience from other regions can be used. Bert van Wee (2015)

4.3.1 Parameters in CBA for cycling

As mentioned above, the methodology of transport projects for car infrastructure and cycling infrastructure differ to some extent. The importance of the context for cycling is higher than for car infrastructure. One of the key aspects in the preparation of CBA is the decision on which parameters to be included in the analysis. According to Bert van Wee, it is very risky to use

parameters and models estimated for other cities and countries, because each case is different. For example, cycling is extremely popular in some western countries like Denmark and The Netherlands, but in the Eastern Europe cycling is almost absent. Due to political and cultural differences it is not appropriate to "copy-paste" the existing methodology. Other factors that obscure the transfer of data from different countries are the topography, weather, the levels of cycling and land use patterns, which differ a lot from country to country and are not essential for other transport modes but should be considered in CBA for cycling. (Wee, 2015). An important point that should be considered while conducting any CBA is to know what can be reached by the analysis and not include effects for which there is a lack of knowledge. However, this does not mean that parameters that evaluate sustainability and livability should be excluded due to their difficulties to be given a monetary value. (OECD, 2011)

From all said above it appears that the methodology for CBA can vary from project to project and from region to region, especially in regard to CBAs for cycling. Any CBA relies on the parameters chosen at the beginning of the analysis. Gosling (2018) suggests that the number of parameters considered in EU guidelines is limited. Based on the existing knowledge and literature that exists the author lists 14 parameters that should be included in any CBA framework:

Parameter	Definition
Environment	
Climate change	Cost linked to GHG emissions – CO_2
Air pollution	Cost of economic and health effects of NOx, PM2.5, PM10, SOx, VOC, and O3.
Noise pollution	Cost of noise including comfort costs, property values and health costs
Soil and water quality	Contamination of soils and ground water due to pollutants from traffic

Land use and infrastructure	Cost of land used for parking; roadway land and loss of ecosystem service values
Traffic infrastructure maintenance	Cost of infrastructure maintenance administration and traffic regulation
Resource requirements	Materials used for construction of the cars/bicycle infrastructure
Travel time and vehicle operation	
Vehicle operation	Cost of owning and driving a transport mode, including taxes, insurance, fuel, depreciation, etc.
Travel time	Cost of travel time of a specific transport mode
Congestion	Cost of the congestion which affect other road users. In that cost additional travel time, operating cost, fuel cost, pollution, climate change, accidents and noise related to the caused congestions
Health, accidents, and comfort	
Health benefits	Cost of reduction in sick days, benefits of prolonged life due to physical activities and savings to the health system.
Accidents	Cost of fatalities (deaths), minor and major injuries. Material damages linked to accidents
Safety and dis(comfort)	Cost of perceived accident risk in traffic because of exposure to motorized traffic, including the discomfort of exposure to exhaust emissions
Quality of life, branding, and tourism	
Branding and tourism	Value linked to the status of livable and vibrant city, including value of open spaces for tourism and branding.

Table: 2 Parameters considered in CBA transport contexts (Gossling, 2018)

4.3.2 Arguments for promoting cycling by integrating CBA for cycling

By reviewing and comparing different transport CBA frameworks, it can be concluded that the existing European Union methodology of preparing CBA often underestimates the cost of cars and does not include effectively the cost and benefits linked to active transport modes. The greatest issue regarding the existing CBAs is that its context ignores some important cost parameters. That is why the author suggests that the CBA framework should be expanded and altered. Moreover, CBA should be easily used to compare the costs and benefits of different transport modes, including active transport modes like cycling and walking. According to Gosling a widened CBA framework in the context of European Union will better include the range of externalities from different transport modes and will be used to better evaluate and understand the consequences of projects regarding transport investments. (Gossling, 2018)

As active transport modes are becoming more popular in European cities and across the world in general, the recent data proves that the number of people cycling increases where a high-quality bike infrastructure is integrated. Therefore, if cities want to increase cycling levels, they need to redesign the transport and urban infrastructure in favor of cycling and walking. That is why the analysis which would guide the decision making should be accurate and efficient.

5. State of the Art - Best practices across Europe

The following chapter will investigate the best practice of CBA for cycling in Europe in order to gain more knowledge of the matter. The main aim is to use them as a sample for the project further on, mainly focusing on the parameters and unit costs of the CBAs, but also considering the political framework of those cases. Moreover, by comparing the existing CBA this chapter seeks to find possible drawbacks in the examined cases in order to understand how the existing CBA should be updated.

Although CBA is extensively used in transport project assessments across Europe, in most countries there is a lack of discussions regarding cost and benefits of cycling (Gossling and Choi, 2015). However, knowledge from Nordic countries' CBA of cycling have been investigated and several studies and examples are now available (Nordic council, 2005) Alongside that, cost benefit analyses for cycling are provided by Buis (2000) for Amsterdam, Bogota, Delhi, Morogoro. In Canada, the Victoria Transport Policy Institute published a

comprehensive comparison of car, bicycle, walking and other transport modes (Litman & Doherty, 2011).

The implementation of bicycle infrastructure is seen as a method against the costs of air pollution, congestion or noise. It was concluded that cycling makes positive contributions to the economy because it can limit the negative impact of transport externalities, like pollution, climate change, congestions, vehicle operation, accidents and other effects which will be discussed further in the project. In general, all studies proved the benefits of cycling over the cars. (Gossling, 2018)

Countries like Denmark and The Netherlands are leading in pro-bike culture and are good examples of well-integrated infrastructure and good political landscape for promoting biking as a daily transport mode (Gossling, 2018). They can therefore be used as an ideal source of data and approach for countries that make the first steps into cycling. In many cities, policy makers appear keen to increase the numbers of cyclists in the daily transport practices. However, such policies raise the question whether such infrastructure is economically efficient, and whether it is worth it the investment. In order to prove its benefits, countries like Denmark and The Netherlands use an updated CBA to assess bicycle infrastructure projects. According to Gossling (2015) any step taken to support cycling is expected to result in some extent of transport mode shift. We can look at the best practices and tools around the world to gain the knowledge needed for this transport transformation. Most of the studies regarding cycling demonstrate that bike cultures evolve when the infrastructure provides safety, speed, and comfort. To provide those requirements a wide range of interventions must be implemented in cities, like separated bicycle paths and tracks, signed bicycle routes, bike boxes, traffic signals, prioritizing cyclists, bike parking, bike stations, integration in the public transport etc. Consequently, such interventions need significant urban re-design, a large range of planning and building which require a solid amount of investments. This is the main reason for many cities to look at the implementation of new transport as a risky investment. Therefore, various studies are needed to understand cost and benefits related with cycling. (Gossling, 2015)

5.1 Denmark

In Copenhagen, a study by COWI and City of Copenhagen (2009) compared the cost of cars with bicycles to derive conclusions regarding the financing of transport infrastructure. This

study has more recently been complemented with an economic analysis of walking in Copenhagen. (Litman & Doherty, 2011).

Cost benefit analyses have been made in Denmark in the report from the Danish Ecological council: Cycling, Environment, Exercise and Health". According to this report, more cycling increases the health of the Danish population. It is proven that public investment in cycling infrastructure and initiatives have socio economic benefits. Therefore, they conclude that the government should prioritize such investments in order to stimulate physical exercise and public health. So, the investments are allocated in a way that municipalities which are interested in promoting cycling infrastructure can apply for the financial means (Gossling, 2015)

Copenhagen aims to become CO2 neutral by 2025 (World Economic Forum, 2019). To achieve this ambitious goal, environmental economics are greatly used in decision making. Copenhagen's focus was aimed at the externalities which are caused by the two most used transport modes, e.g. cars and bikes. Copenhagen Municipality required a development of CBA methodology evaluating infrastructure projects regarding the above-mentioned transport modes. The analysis included assessment of transport cost, health, security, comfort, transport time, branding and tourism. This analysis revealed that the cost of driving a car is more than six times higher than cycling, appraised at 0.5 euro and 0.08 euro per km, respectively. (Gossling, 2015)

The first publication regarding cycling in Copenhagen was in 2002 with the city's first bicycle strategy – "Cycle Policy 2002-2012". This paper (strategy) provided the first comprehensive vision for a "bicycle city". It was followed by various strategy documents as the Bicycle Track Priority Plan 2006–2016 and the Bicycle Strategy 2011–2025. Following these strategies, a CBA framework has been developed to compare the costs and benefits of cycling and car. This was made to justify infrastructure development and re-allocate the urban space throughout the city. (Gossling, 2015)
According to Choi, cycling has not been considered in European Urban transport CBA. So far Copenhagen is the only example for a CBA focusing on externalities comparing cars and bikes. This CBA has been used to guide and implement policies, which proves that such comparative frameworks can guide decision making and investments. (Gossling, 2015)

5.1.1 CBA in Copenhagen

Cost-benefit-analyses for cycling have been made in Denmark in the report from the Danish Ecological Council.: "Cycling, Environment, Exercise and Health", The Ministry of Transport in Denmark developed the CBA manual to investigate the economic impact of cycle projects. According to Gossling (2015) there were three key aspects in the process of creating the CBA framework for cycling in this case. The first one was to decide which parameters to be included in calculations, second there should be an agreement on the unit costs and then an assessment on traffic effects – like changes in the km cycled, transport time changes etc. (Gossling, 2015)

One of the most important aspects in Copenhagen CBA for cycling is the political consensus, regarding the included parameters. According to Gossling (2015) this consensus is a specific and unique achievement.

Unit costs

To calculate the unit costs The Ministry of Transport reviewed the existing literature on cost/benefits and applied them in the Copenhagen context "Unit costs are annually updated, and consider developments in costs (e.g., fuels and energy costs) and GDP, net price indices, discounting, and taxes/fees, as well as new insights regarding externalities. This allows for extrapolation, and values are available up to the year 2090. Parameters are compared in Euro per km cycled or driven." (Gossling, 2015)

Unit costs change over the time, moreover the knowledge base for these units is evolving as well. For instance, the social preferences are changing as well as the environmental impacts which reflects citizens' health as well. The calculation and allocation of the unit costs are considered as a process. In the case of CBA for cycling in Copenhagen, this process started by creating a national economic manual which summarizes methods used to calculate the costs and benefits of transport projects around the world.

The following table summarizes average costs for cycling and car (per km) in Euro as used in calculation by the City of Copenhagen in an overview of COWI (2009) Unit costs are presented as positive (+) for costs and negative (-) for benefits. (Gossling, 2015)

Parameters	Characteristics	bike 16 km/h	car 50 km/h
Time costs	This value is based on the citizen willingness to pay for time, based on Danish Value of Time Study. This value varies considerably in societies	0.672	0.215
Vehicle operating cost	Costs for driving a car, including fuel, engine oil, taxes, maintenance and depreciation costs. Costs are calculated as market prices per km driven	0.044	0.137
Health	It includes reduced costs for medical treatment, also fewer sick days. It is calculated on the bases of avoided costs of physical inactivity	-0.391	0
Prolong life	It is relevant mostly as private benefits.	-0.348	0
Accidents	It includes public services, deaths, loss of productivity due to injuries, the cost of material damages	0.105	0.030
Air pollution	It includes $PM_{2.5}$, NO_x, SO_2, CO, HC, which have impact on the people health and environment	0	0.004
Noise pollution	It accounts both health costs and discomfort. The costs include sick days, health services, premature deaths and are based on national health assessment.	0	0.007

Climate change	The climate change is based on the wide range of greenhouse gasses but in transport the gas considered as the most potent is CO_2 Unit costs are calculated on values of the trade of CO_2	0	0.048
Road deterioration	It is based on the infrastructure lifetimes. The costs are calculated as average and based on the amount paid for service contacts	0	0.01
Congestion	It is defined as "the discomfort mutually caused by traffic participants through reduced movement" It is measured as the cost to drive additional km, comparing to a situation of free traffic flow	0	0.069
Branding and tourism	In the case of Copenhagen cycling produce a branding value for the city. Moreover, it has a positive effect for tourism, this value is based on the cost of the value to the cost of tourism related investments	-0.003	0
summary		0.08	0.50

Table 3: Average costs for cycling and car (per km) in Euro as used in calculation by the City of Copenhagen (Gossling, 2015)

5.2 The Netherlands

In the Netherlands for example, the use of CBA is mandatory for all transport projects, after the budgets of the Ministry of Transport and Water Management and Ministry of Housing, Spatial Planning and the Environmental merged. (Nordic council, 2005)

In the Netherlands context, Buis (2000) provided cost benefit analysis for cycling in Amsterdam. This paper was published as "The Economic Significance of Cycling". The study

conducted by Buis (2010) investigates various benefits and saved costs due to the implementation of integral bicycle policies. The author states that an executive cost benefit analysis which shows the economic benefits of cycling could put cycling on the political agenda. (Buis, 2010): In the following table a number of assumptions from the Netherlands study are represented

Parameters	Benefits
The cost of traffic and traffic facilities	There are cost savings from infrastructure for cars and public transport because cycling infrastructure has the lowest price
accessibility and use of space	There are cost savings related to the fact that cycling requires less space both on road and parking and mitigate congestions
urban economy and life quality	the bicycle can help reduce the negative impact from motorized traffic
improving the environment	cycling can improve and reduce the urban air and noise pollution
health	Cycling has a major effect on the prevention of a number of illness
traffic safety	Cycling does not cause severe accidents. When the infrastructure is designed in a proper way accident decline.
the role of bicycle for employment	creating industry for bike sector, which can lead to local economic activity. Moreover, cycling can be used to increased incomes at work
Travel costs and individual mobility	Cycling is not only cheap a cheap mode of transport for society and individual's safe money using bikes in their daily transport habits

Table 4: Parameters used in CBA for cycling in The Netherlands Buis (2010)

Moreover, a CBA for bicycle bridge in Utrecht, The Netherlands is presented. The parameters, costs and benefits are shown in the table below. Although, the CBA is prepared for three scenarios – pessimistic, neutral, and optimistic, the table represents the average values e.g. the neutral scenario. (Wee, 2015)

Parameter	Cost (-) / Benefit (+) million €
Investments	-21.5
Maintenance	-2.5
Travel time (gains cyclists)	29.1
Travel time (gains car users)	5.4
Travel cost reduction	1.8
Labor productivity	-0.8
Life years	-0.3
Taxes on car fuels	-0.3
Subsidies public transport	0.7
Emission pollutants	0.4
Noise	0.2
Road safety	2.4
Total benefits	38.5
Benefits minus costs	14.6
Benefit cost / ratio	1.7

Table 5: Parameters and unit costs included in CBA for bicycle bridge in Utrecht, The Netherlands (Wee, 2015)

5.3 Sweden

Another example can be found in Sweden where The Nordic Council of Ministers, The Swedish Road Administration and the Swedish Environmental Protection Agency initiated a project which aimed to improve the decision basis for investments in bicycle infrastructure to such extent that they are comparable with other means of transport. In Sweden, the three main public sector planning authorities related to road infrastructure are the Municipality, the County and the Parliament. Two of these actors, the Municipality and Parliament, may be defined as the main actors relating to issues concerning bicycling, while the county mainly plans for infrastructure investments in roads for motor traffic (excluding light motorcycles etc.). (Nordic Council, 2005)

In this case, the cost values are based on previous experience for bicycle projects, estimated values, and documents from contractors. In the table are the parameters of CBA for bicycle infrastructure and their features are described.

Parameters	Characteristics
Travel time	In this case the value of travel time is distinguished in dependence of the trip taken on cycle track, cycle path or mix traffic. The main aim here is to estimate the cost differences in comfort and security. The travel time value of cycling on cycle lanes is calculated to be 70 SEK per hour while in mixed traffic this number is 90 SEK.
Delay	The values applied for this parameter are similar to the used ones in CBA for public transportation. A value for waiting time is proposed at the cost of 140 SEK per hour
Comfort and security	included in this parameter are measures like improved surface quality, separate cycle paths, safe cycle parking, road signing and marking etc. which are estimated at the willingness to pay between 25.5 and 53 SEK
Cycling operating	This cost is estimated 0.20 SEK per cycle km which include repair and maintenance, insurance alternatively theft. If estimated capital cost is added this cost would be 0.60 SEK
Heath improvements for new cyclists	The assumption considered in this study is that "bicycle measures lead to more cyclists, more cycling leads to fewer inactive people and decrease in obesity, which leads to decrease in medical costs and excess morbidity". The value per generated

	cyclist is estimated on average of 2600 SEK and 8300 SEK in case of increased cycling for older inactive people.
Road safety	This parameter is estimated by methods taken in conventional CBAs for transport projects
External effects for society	This effect includes CO2 emissions, noise, accidents, etc

Table 6: Parameters used in CBA for cycling in Sweden (Nordic council, 2005)

5. 4 Norway

The recent study from Norway investigates the cost benefits of cycling and walking in three Norwegian cities - Hamar, Hoksund and Trondheim. The main assumption of The CBA conducted assumes that the shift from car to cycling leads to reduction of health costs, due to external parameters like air and noise pollution. Moreover, this study proves that parking costs for bikes are considerably less than those for private automobiles. In this case the Norwegian Parliament's request to the Government to ''prepare a National Cycling Strategy, "the main goal of which is to make it safer and more attractive to choose a bicycle as a means of transport." A project group working on a National Cycling Strategy in Norway initiated the study of these arguments thorough CBAs (Nordic Council, 2005)

Similar to the other cases, the CBAs in Norway embrace common parameters used to assess transport projects and additional ones used for the particular investigation. The parameters considered in this case along with arguments and characteristics of these parameters are explained more detailed in the following table.

Parameters	Features (characteristics)
Traffic accidents	A safe constructed walk and cycling track network is likely to reduce the number of traffic accidents. However, in this case it is assumed that the number of traffic accidents will remain unchanged in order to avoid an overestimation of any benefits.
Travel time	In this CBA it is assumed that travel time for pedestrians and cyclists is not changed due to the new network, but the travel times for cars who do not change their

	transport mode to cycling or walking is reduced. This is included in the analysis as reduced congestion costs.
Insecurity	Insecurity that is felt by pedestrians and cyclists is estimated at 2 NOK per kilometer and for cyclists with average speed of 10-20 km/h this cost is between 20 and 40 NOK per hour
School bus transport	This indicator is not common for the CBA's for other transport investments. In the evaluated cities, school children are offered transport to and from school if the road that they take to school is classified as dangerous for walking or cycling. In the analysis it is assumed that half of the children will not need such transport if a walking and cycling network is provided. Based on estimate costs it is calculated that the society pays 4680 NOK per year for child
Severe diseases and ailments and less short- and long-term absence	Regarding the short-term absence, the economic savings are estimated at 2500 per person employed who becomes more physically active Regarding severe diseases and long-term absence, the economic saving per person per year are estimated at 7300 NOK
External costs of road transportation	The external costs that are included in the CBA in Norway are: CO2-emissions, air and noise pollution, congestion, and infrastructure costs. The Norwegian Ministry of Transport and Communication and the Public Road Administration use Eriksen's* values for external costs in the transport projects. In the CBA's for cycling the same values are used in order to make the results comparable.

Parking costs	It is assumed that trips replaced by cycling and walking reduce parking costs for businesses at an average of 683 NOK per month. Parking costs are calculated at the basis of price cost that companies pay for parking spaces in the different cities

*Eriksen – The study was initiated by the Norwegian Ministry of Transport as part of their input to the National Transport Plan 2002 – 2011. This plan includes all transport modes and all infrastructure investment and other policy plans for this eight-year period. The present study aims to calculate the marginal external effects of transportation activities in Norway. (Miola et.el., 2008)

Table 7: Parameters used in CBA for cycling in Norway (Nordic council, 2005)

5.5 CBA framework in Europe

Considering how important the CBA is for transport projects, the European Commission (EC) created a handbook for projects above 50 million euro. The main aim of the European cohesion policy is to deliver growth and to target objectives which are in symbioses with the European strategies. In this framework it is essential to choose the best quality projects and tools in order to evaluate the projects which lead to the above-mentioned targets. In that sense, CBA is required as a basis for decision making on the co-financing of major projects included in operational programs, of cohesion policy CBA is required as a basis for "decision making in operational programs of the European Regional Development Fund and the Cohesion Fund. According to the European Commission, the purpose of CBA is to provide the best allocation of resources and demonstrate the convenience for society in particular projects. Still, in the guideline prepared from European commission for CBAs in European content, projects regarding cycling infrastructure are not explicitly mentioned. For instance, to change mobility from car to bike is worth only 0.30 euro/pkm, so we need to consider changing our policies However, the European guidelines provide a legal framework and recommendation of the parameters which should be included in CBAs for different projects for transport projects. (European Commission, 2014)

The parameters included in CBA for all the above-mentioned CBAs are summarized in the following table, showing which parameter has been considered in the particular analysis:

Parameters	Definition	ECF	DK	EC	NL	NO	SE
Environment							
Climate change	Costs of climate change linked to greenhouse gas emissions	yes	yes	yes		yes	
air pollution	the costs related to economics and health effects of CO, NO, PM2.5, PM10, SO, VOC and O3	yes	yes	yes	yes		
noise pollution	the costs of health issues related with noise pollution	yes	yes	yes	yes		
Soil and water quality	pollution of groundwater and soils related to contaminants from traffic - heavy metals, road salt, hydrocarbons, etc.	yes					
Land use and infrastructure	space for infrastructure, parking space, roadway and parking value, loss of ecosystem values	yes				*yes	yes
traffic infrastructure maintenance	cost of infrastructure maintenance, including administration and traffic police		yes		yes		yes
resource requirements	resources needed to build cars bicycles, the cost to recycle resources, the cost to deposit wastes	yes					
Travel time and vehicle operation							
Vehicle operation	cost of owning and operating a particular transport mode, including duties and taxes, insurance and vehicle depreciation	yes	yes	yes			yes
Travel time	The cost of travel time related to a particular transport mode	yes	yes	yes	yes	yes	yes

Congestion	cost of roadway congestions, including additional travel time, operating costs, fuel costs, reliability costs, pollution, climate change, accidents, noise and air pollution		yes		yes		
Health accidents and perceived comfort							
Health benefits (better health, productivity, prolonged life	savings to the healthcare system as a result of active lifestyle, reduction in sick days, longer lives	yes	yes		yes	yes	yes
Accidents (collisions)	The cost of major and minor injuries, attributed to medical costs, pain and suffering, loss of life. Material damage associated with car accidents	yes	yes	yes	yes	yes	
Perceived safety and discomfort	Perceived accident risks in traffic as a result of exposure to motorized traffic, discomfort because of exposure to exhaust fumes	yes			yes	yes	yes
Quality of life, branding and tourism							
Quality of life, branding and tourism	Value derived for being considered a progressive city with a high quality of life; value of open spaces for tourism		yes				

*only parking cost

Table 8: Comparison of parameters considered in CBA for transport projects (EC, 2014; Nordic Council, 2005; Gossling, 2015)

A conclusion from the report from the Nordic Council regarding CBA for cycling propose a number of parameters that should be included in future analysis and a table of this parameters and values used in the different approaches to CBA are represented in the table below. Unit costs are presented as positive (+) for costs and negative (-) for benefits.

parameter	DK	NO	SE
Travel time	4.7 €/hour	No value	6.65 €/hour
Health benefits	-2.35 €/hour	-1.84 €/hour	-3.12 €/hour
Short term absence	Value included in health benefits	No value	No value
External costs – CO2, noise, and air pollution	-0.05/pkm	-0.037€ to -0.13€/vkm	-0.043€/vkm
Accidents	No value	No value	0.076€ - 0.17€/injury accident
Comfort	0.06€/cyclekm	No value	0-1.9€ /trip or 0.47€/cyclekm
Dalay	No value	No value	13.29 €/hour
Parking costs – benefits from trips replaced by cycling per person	No value	-62.58€ /month	No value

**Vkm – vehicle km, pkm – passenger km*

Table 9: Parameters and unit costs from best practices in Europe (Nordic Council, 2005)

In addition to what has been discussed in this chapter, recent studies which used CBA framework have been used to estimate the cost of private cars and cycling and compare it within the boundaries of European countries. The study showed that each kilometer driven by car costs of 0.11€, on the other hand cycling costs - €0.37 for kilometer driven where the negative costs represent benefits. Calculation of the overall costs for cars is estimated to be 500 billion € per year. Opposing the costs that cars cause, cycling brings benefits of 24€ billion per year. (Gossling, 2018)

6. Theories

6.1 ANT

Actor-Network Theory (ANT) is a methodological and theoretical approach that aim to describe what society is without excluding non-humans. The purpose of ANT is to analyze how different actors form network that can cooperate to achieve a common objective. In this case build a proper bike infrastructure in the capital of Bulgaria-Sofia. Most social theories conceive society as a connection of humans, 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. (Rydin, 2015)

ANT can be used as an analytical tool. This theory can help researchers understand the network processes within in and how by creating these networks a social goal is reached. Everything that happens in society is made by a collection of humans and non-human actors. We, as a society, are constituted by interactions. However, actor or group of actors does not exist just by itself. It is a complex set of networks. For example, if we look at transport projects, there is no project without states, laws, organizations, individual agents, physical infrastructure, paperwork etc. Actor-Network theory can be used to frame the changes needed to set up an alternative decision-making support tool to analyze, from a decision-making perspective, the potential of cycling infrastructures across Sofia. (Rydin, 2015)

ANT provides a framework to understand the dynamics behind an extraordinarily complex system of interactions, relationships, and controversies. The theory will be used to define actors, their identity, their vision, their knowledge on the project and their knowledge, which one of them could be the leader of such a project and where possible conflicts could be anticipated and avoided in order for the project to succeed. 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 product or a service more accessible or changing the behavior of its users. (Rydin, 2015)

Translation

Following the ideology of ANT, 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 (1986), namely problematization, interessement, enrolment

and mobilization. These four stages are often summarized in the notion of translation. (Rydan, 2016)

The problematization is the phase on the discussion on what is the problem and what solutions can be considered to solve it. The second one – interessement appears when one or group of actors attempt to convince other to believe in their idea and knowledge. The network is further assembled by enrolling new actors. In other words that is the stage when a spokesperson agrees to be part of the network. The final phase mobilization is the moment when actors follow spokesperson. The spokesperson as Latour states is one who is very talkative and "speak for the group existence. No matter what is the ideology of certain network the actors need someone who define them what they are, what they have been and what they should be.

According to Callon (1986) the four concepts are not sequential to each other; they are rather synchronic and parallel. However, the role of these processes, namely translation is particularly important in linking actors within a network. The understanding of these phases gives a framework which allows us to understand failures of enrolments in cases of rare disinterest. Of course, we can say that due to human nature the sense of interests for each actor differ from each other. Moreover, human social skills play an essential role in forming the processes of translation. (Rydin, 2016)

In sense of ANT there is usually a need of "package of multiple objects" to create the value of translation to enroll actors. In planning contest if a developer wants to please the unhappy groups, they may need to offer attenuation of the project or facilities which would be profitable for each affected actor. For instance, if a new cycle path is planned, the construction of bike lane is not enough, rather there is a need of amenities like interaction in the public transport, bike parking, bike stations, traffic signals, etc. (Rydin, 2016)

6.1.1 Main elements in the framework of ANT

According to Rydan (2016) three elements are essential to the process of translation – black boxes, immutable mobiles and mutability.

Black boxes - This concept is referred to a term adopted from early computer technicians, meaning a "device whose details were too complex to be appreciated by the average person – in which place there is a little box with input and output" (Rydin, 2016). Another explanation of the "black boxes "could be by hard (material) or soft (social) entities which are embodied attempts to standardize the relationships and processes and yet do not necessarily require an

explicit agreement to a relationship between actors or relationship along more than one dimension. (Rydin, 2016)

Immutable mobiles are fixed objects, in other words their "network identity" stays unchangeable, even when the links between the actants in the network are altered or the actors are leave out. This could be texts or laws, that are durable, and they standardize the practices and translate the planning in certain not changeable way. Rydan (2016)

Networks are described as fluid. In that sense actors – human and non-human can alter as a reply to some network conditions. In these processes the most essential role plays the mediator. Mediators transform and modify the network meanings. Rydan (2016) argues that it is important what role play the entity which alter the situation –intermediator or mediators, which main characteristics will be discussed later in this chapter. This characteristic of the network is described by Rydan as a "level of mutability"

Intermediaries and mediators - An important part or different way of analyzing the process of creating networks is to investigate how intermediaries and mediators perform. According to Latour (2005) intermediary is what transport meaning. Intermediaries can be human or non-human actors and their role is to connect actors within the network. Some authors argue that intermediaries play rather passive role in the translation of the network. Defining intermediaries' input is enough to define its output. Even if the intermediary includes many parts and actors, in practice it is not only a black box, but a black box counting for one. (Latour, 2005)

Mediators on the other hand can transform and modify the meaning that the elements have within the network (Rydin, 2016). Knowing what their input is never gives a prediction of what the output will be. Therefore, they role should be considered every time due to its specificity. Moreover, Latour states that mediators cannot be count as just one – "they might count for one, for nothing, for several, or for infinity" (Latour, 2005) Even if the mediator look simple it may become very complex and its role in the network is way more important than the intermediary. A network is made, constructed or alter through many means and tools, but the result becomes visible and significant when the means and tools are treated as mediators, instead of intermediators. (Latour, 2005)

Intermediators has only a passive role in the process of transferring knowledge within the network. On the other hand, mediators allow the network to develop in an unexpected way because have the power to alter the transferred knowledge and meaning of the network. In

other words, in certain circumstances some actors can be influenced by others. defines this characteristic as mutability. (Rydin, 2016)

6.1.2 The link between CBA and ANT and its relevance to the project

According to Rydan (2016) the main reason for urban planners to adopt ANT is to understand better the surrounding world. In-practice planning is a synergy of physical (material) and social (Rydan, 2016). For instance, the planning and development lies on addressing both problems social (increasing population and dependence on private cars) and physical (an inadequate infrastructure), due to bad governance (again social aspect).

By using ANT planners can understand the network of relationships and the processes which occur within the frame of certain network

Enrolling is the process where the actants form network relationships on specific terms. All actors work together in a particular ways and patterns. An important role in the process of enrolment play the mediator as mentioned above. According to Rydan (2016) there exist four main types of mediators:

- Human beings
- Literature – books, articles, etc
- Technical artefacts – machines, non-human objects
- Money – as institutional mean of exchange

Looking throughout the lenses of ANT, CBA can be seen as a network. In that sense the ANT gives us the framework to analyze this network and to follow the processes and actors which uphold it. For instance, CBA includes the appraisal of potential impacts of chosen parameters during a specific period of time, their monitory evaluation and the comparison of costs and net benefits. Due to the ideological orientation of the actors who are involved in the process of evaluation, the externalities that could have an impact may or may not be included in the CBA. However, if the selection of parameters is asserted explicitly, CBA can contribute to more transparent consistent and knowledgeable basis for decision making. (European Commission, 2014)

7. Methodology

The following chapter will expand on the various methods throughout the investigation of the research question, how the analyses were prepared and why this methodology was chosen. According to Bryman (2012) social research practices include literature review, research questions selection of case, choice of theories, data collection and analysis. Still, we must consider that the process of research does not always go entirely the way one planned. (Bryman, 2012). To answer the research question, various methods from quantitative and qualitative fields were used.

7.1 Case study research design

A research method is the technique of collecting, organizing, and interpreting data. It can involve certain instruments such as interviews, surveys, observation, etc. This research is designated as a case study focused on Sofia, specifically projects related to the transport situation in the city. In general, a case study encompasses the detailed analysis of a single issue, namely CBA in Sofia. According to Bryman (2012) the case study is associated with a single entity as a location, community, or organization. Case studies employ both quantitative and qualitative methods. They do, however, often use qualitative methods such as interviews because this research method is considered as helpful in the detailed examination of a case (Bryman, 2012). Examining how a CBA for cycling can improve the decision making in the capital of Bulgaria is an example of a case study because it examines a particular area (Sofia, Bulgaria) on a specific problem (CBA) by using a well-researched theory (ANT). Moreover, the social scientist Robert K. Yin refers to a case study as when a "how" or a "why" question is presented, which is the question in the problem research of this paper. (Yin, 2014)
Important point in the case study is how a single case can be representative for others. This is seen as a challenge considering the fact that each case study is limited to its own boundaries. However, this study aimed to find features which can be found and applied to other cases regarding CBA.

7.2 Literature review

According to Bryman, "once you have identified your research question, the next step in any research project is to search the existing literature and write a literature review." The main task at this early stage included reviewing the main theories and studies concerning the chosen area of interest. This gave the foundation for the writing of a literature review, which shaped an

essential portion of the paper. It is important how we search the literature and engage with the ideas of other authors because that is the way how we narrow our research question. It is also crucial to understand some of the prospects of the literature review and to know how to assess the quality of existing research. (Bryman, 2012)

This is not only a question of repeating the theories and beliefs of other scholars, but also being capable to understand what they have written, using their ideas to acknowledge a point of view or argument. The aim of exploring the existing literature should be to recognize the following issues:

- "What is already known about this area?"
- "What concepts and theories are relevant to this area?"
- "What research methods and research strategies have been employed in studying this area?"
- "Are there any significant controversies?"
- "Are there any inconsistencies in findings relating to this area?"
- "Are there any unanswered research questions in this area?"

(Bryman, 2012)

Therefore, the first step as mentioned was to investigate the problem in order to face the existing issues and to see what has been done so far. In Sofia there is a lack of cycling strategies and politics (Vision of Sofia, 2019). Moreover, there is not a great deal of Bulgarian literature regarding CBA. Therefore, a literature search regarding CBA in European context was made. A number of guidelines and handbooks for CBA were considered. In addition, document study of the external costs of transport across Europe were made.

Sources of the best practices in the field were reviewed during the process of data collection, which can be found in chapter 5 (State of the Art). The focus within this research was on existing CBA for cycling and the parameters included in these studies. Moreover, literature related to the role of CBA in other countries was reviewed.

On the other hand, in order to get familiar with the existing practice of CBA for transport projects in Sofia, the existing literature about this case was investigated. This included document study regarding the CBA for the Sustainable Urban Mobility Plan and the CBA for the Metro extension in Sofia.

This literature research was made parallel to preparation and conducting of qualitative interviews with experts in the researched field.

7.3 Data collection

Knowing how and where to collect data is a crucial point in the research design. It is necessary to get multiple and balanced sources of data in order cover the scope of the research. The main methods of collecting data in this report was via document studies and qualitative interviews.

7.3.1 Qualitative interviews

According to Bryman (2012), interviews are the most used method within qualitative research to get a better understanding of the world we live in. Several expert interviews were conducted. All the four interviews were semi-structured because they give an option to the interviewer to ask further questions depending on the response of the interviewees. Semi structured interviews contain a sequence of questions in which the order could be altered due to its more informal character. These interviews contain a base question guide - "interview guide" (see Appendix X) but as just mentioned, do not follow a strict order. (Bryman, 2012)

The questions included in the "interview guides" were based on prior literature and document studies and were inspired by the theories used to investigate the research question. The interviewees were chosen because their fields of work and position were relevant to transport in Sofia. Namely the people that were interviewed are part of the preparation or evaluation of CBA in Sofia context or to be involved in the processes of transport project in the capital of Bulgaria. From my previous research and work within the researched area some contacts already existed, which made it easier to contact representatives of companies, authorities and organizations involved in transport planning in Sofia.

It is important to mention that due to the COVID-19 pandemic and accompanying quarantine period during the time of this research, all the interviews were conducted online or via email communication. Although online interviews run the risk of bad connection and inability to follow the body language (Bryman, 2012), this method appeared to be a good alternative to in person interviewing.

The first interview was with Petya Petrova, a freelance architect. She is a member of the most active NGO which supports the development of cycling infrastructure in Sofia - VeloEvolution. As she is a coordinator of the "Planning and Infrastructure" group within the organization, she performs site inspections that are needed to make the model for bike paths

and lanes. Moreover, Petya/ attends most of the meetings regarding bike infrastructure in Sofia. The aim of this interview was mainly to gain information about who supports active transport and Sofia and whether analysis of costs and benefits has been considered for cycling in this case. Further this interview gave additional contacts for interviews.

The second interview was with Tsvetan Kolev, a transport engineer (planner) in Sofproekt. Sofroekt is a company which makes analysis, forecasts, strategies, and projects, regarding the urban planning in Sofia. The purpose of this interview was to gain information regarding the role of the company related to the preparation of the Sustainable Urban Mobility plan and the CBA prepared for it. Furthermore, this interview gave information about the existing strategic document for urban and transport planning in Sofia and how Sofproekt has been contributing to them. Through the interview, more explicit information about the link between the company and municipality was gained.

The third interview was conducted with Rozalina Kozleva, a manager of InfraprojectConsult Ltd. InfraprojectConsult Ltd is a consultancy company providing engineering and consulting services in the Bulgarian market. The company has prepared projects, including Feasibility Studies, Cost-benefit analyses and completed the application forms for obtaining a grant under the Operation Program "Transport" and Operation Program "Regional Development" of several large infrastructure transport projects, such as Trakia Motorway, Hemus Motorway, Sofia Metro, Modernization and Development of Sustainable Urban Transport in Sofia, Plovdiv and Ruse, a number of railway rehabilitation and modernization projects and the analyses for granting a concession on most of the Bulgarian ports. The purpose of this interview was to gain information about CBA in Sofia, what parameters were included, on what base and what unit costs were used. Moreover, questions like who required the CBA, what was the purpose of preparing it and who validated it were discussed within this interview.

The last interview was with Vania Markova, a member of the road department in one of the regions in Sofia Municipality. From this interview, information about the processes regarding transport projects in the Municipality and how the departments communicate with each other and external companies and organizations was gathered.

In addition, I had email communication with Aleksander Vitanov, a transport engineer and former member of Sofproekt. He prepared most of the existing transport models in Sofia and the main reason to contact him was to understand who and how uses the data from the

transport models that he has prepared. Alongside that, what the models include, e.g modelling of car traffic, public transportation or active transport.
The overall reason to conduct these interviews was to get better insight of the current efforts done thus far regarding CBA in Sofia. Likewise, the interviews aimed to investigate the role of CBA in decision making in the capital and when, how, and who is involved in these processes. The following figure shows the structure of data collection

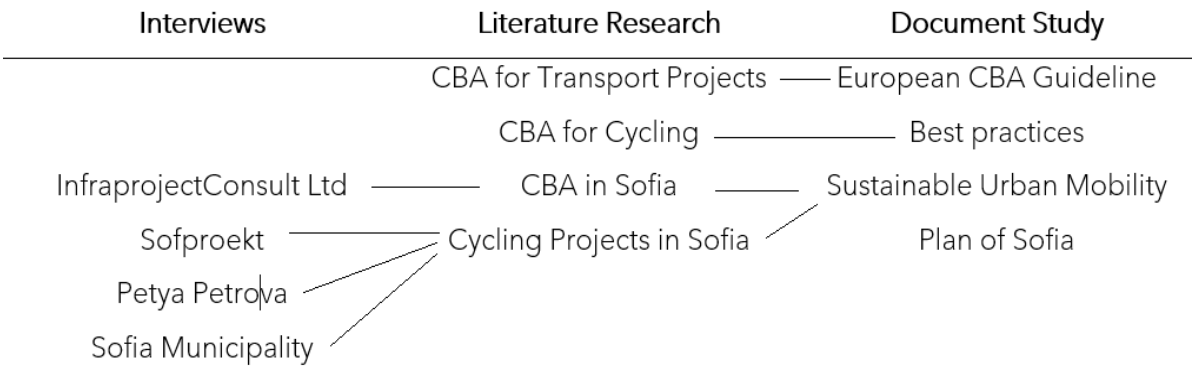


Figure 7: Structure of data collection (own illustration)

7.4 Methodological approach for the theory

In this project, ANT was used to get an understanding of CBA's actor world in Sofia's case. By applying this approach, it was aimed to gain knowledge on who prepared and validated the existing CBA in Sofia, what parameters and unit costs were considered and what role the CBA played in the decision regarding transport projects in this case. Moreover, ANT was used to expand the knowledge about the actor world within the planning policies in Sofia. According to ANT, CBA should be perceived as a network of human and non-human actors. That is why throughout this research ANT was used to examine the CBA in Sofia and to address the issues within the existing framework of this tool

8. Analysis

8.1 Previous CBA in Sofia, Bulgaria

After research regarding CBAs prepared in Sofia, it was found that the two transport projects for which CBA were prepared are the Sustainable Urban Mobility Plan (SUMP) and the project for the Metro extension in Sofia. (InfraprojectConsult Ltd, n/d)

8.1.1 CBA for SUMP

The main subject of SUMP is to elaborate on documents which gives the main directions for sustainable mobility development in Sofia. The project is governed by the Municipality of Sofia, as a Contraction authority. The plan should have been developed according to the "Guidelines - Developing and Implementing a Sustainable Urban Mobility Plan", published at the European Platform on Sustainable Urban Mobility Plans of the European Commission. The most recent "Sustainable urban mobility plan" - SUMP for Sofia was prepared for the period between 2020 – 2035. The plan includes analyses of the current transport situation and major projects and initiatives about the different transport modes-e.g. pedestrian traffic, bicycle traffic, public transport and intermodality. Moreover, it includes projects about parking management, shared and electric mobility, urban logistic and intelligent transport systems. Within the framework of The Sustainable Urban Mobility Plan of Sofia several strategic objectives were addressed. First, the plan focuses on reduction of the negative impact of transport on human health and environment. The second objective is to improve the safety, comfort, and accessibility for all passengers. Another goal is to increase the attractiveness of the city and to ensure a better quality of life. And last, the plan aims to introduce transport innovations and enhance local mobility and economy. (SUMP, 2019)

Regarding urban planning and sustainable mobility, a CBA assessing the benefits of the proposed plan was prepared. (SUMP, 2019) The purpose of CBA was to evaluate the economical effectiveness of the investments made under the framework of SUMP for the period of 2020 – 2035. The CBA has been prepared regarding the methodology which is placed in the "Guide to Cost Benefit Analysis of Investment Projects by the European commission". The CBA was carried out by the Bulgarian consultancy company – Infraproject Consult Ltd, in accordance with an assignment from the Contracting Authority – e.g. Sofia Municipality.

The analysis was prepared according the "incremental method comparing the plan scenario and no plan scenario". The prepared analysis covers all projects included in the plan (over 210), including those related to bike infrastructure. (SUMP, 2019)

The Cost Benefit Analysis included projects regarding construction of new sections of tram routes and rehabilitation of existing tram and trolleybus infrastructure, delivery of new rolling

stock, further development of existing information systems and intelligent transport systems and construction of new bicycle lanes. (InfraporjectConsult Ltd, n/d)

Financial analysis

To calculate the financial effectiveness of the investments the plan considers the incremental cash inflows and cash outflows. The cash inflows are the project investment costs for construction and operating and maintenance costs. And the cash outflows encompass the incomes from operating activities and the residual value of investments. (EC, 2014)

The main methodology for calculating the financial values of the plan is a method of "discounting cash flows". This method is designed in terms of future income and research for activities and presentation of net cash flows. In the case all the cash flows are calculated on the base of current values in the year of preparing the CBA, without accounting the inflation. All the values and unit costs are calculated and presented on Bulgarian currencies (BGN). For each project, the start date is the year after the construction is completed. The Cost Benefit Analysis embrace time span until 2043. (SUMP, 2019)

The financial effectiveness of the plan is interpreted on the base of two financial indicators – the Financial Net Present Value (FNPV) and the Financial Rate of Return on Investment (FRR). The FNPV is "a quantitative expression of the cumulative effect of the investments made for the entire horizon of the Plan" (European Commission, 2014). The FIRR is the second most important indicator in the process of financial analysis. It incorporates the effect as an average percent of return on funds for the entire Plan Period. In this case, this financial indicator is negative which according to the SUMP report means that the plan could not be realized without grants - mainly EU financial assistance. (SUMP, 2019)

Economic analysis

The purpose of the economic analysis as mentioned in chapter 4 (CBA) is to evaluate the costs of the external parameters which could be part of the plan implementation. It should give an answer whether the investment has made a positive contribution to society and to justify the investing public funding. In general, this is expressed by economic performance indicators like Eonomic Net Present Value (ENPV), Net Present Value (NPV), the and Benefit Cost Ratio (BCR), which definition were presented in chapter 4 (CBA).

Due to the lack of reliable and detailed data regarding the transport in Sofia, (Vision for Sofia, 2019), the consulting company that prepared the CBA used unit costs recommended by HEATCO. HEATCO (Harmonized European Approaches for Transport Costing and Project Assessment) provides a standardized guideline for project evaluation and transport costing in European level. (Odgaard et.al, 2005) The unit costs that have been used were calculated on the base of the country GDP, as they have been borrowed from other countries with the closest GDP to Bulgaria. (Kozleva, 2020)

Moreover, the company used traffic modelling, provided by Alexander Vitanov (Kozleva, 2020). Alexander Vitanov is a transport engineer which work is related mainly with preparation of transport models regarding mass transport and cars.

"Transport model is a computer-based interpretation of the movement in a transport network, within a defined study area, possessing certain socio-economic and land use characteristics" Traffic modelling is usually required for demand analysis, which enables the simulation of traffic distribution on the network thereby providing indication of how trips will respond, over time, to changes in transport supply and demand. many transport models require substantial input data derived from standard statistics and special surveys for building a model of trips, a model of the network and for understanding current traffic flows and demand structure for the purpose of model calibration. This is essential for the model to be sufficiently accurate and have credibility for planning and decision making. the output from the transport model is used to design adequate sizing and features of the investment, to verify the appropriateness of planned infrastructure capacity, and provides quantitative information that informs the scheme design, the CBA "(European Commission, 2014)

The socio-economic effects that are included in the analysis for the Sustainable Urban Mobility Plan are:

- Travel time
- Operation costs
- Air pollution
- Noise pollution
- Health benefits due to physical activities

(SUMP, 2019)

The plan includes a number of interventions that aim to limit the growing number of car commutes and to shift it to trips made by public transport, cycling and walking. However, in order to avoid distortion of the results and reduction of the benefits of the SUMP regarding the "travel time" parameter, the cycling and walking modes were excluded. It could be explained with the fact that travelling by car takes less time than cycling and walking in the current transport system. (Kozleva, 2020)

The calculated economic indicators suggest that the analyzed projects would? lead to an increase in public welfare. As mentioned in chapter 5 (CBA), the main indicator that shows the economical effectiveness of certain project is the Benefit Cost Ratio. In that case the cost benefit ratio of the Plan shows that the benefits outweigh the costs by 47%. As it appeared that nearly half of the benefits result from saved travel time (SUMP, 2019). However, according to the financial report for SUMP Financial Net Present Value of the Investment which is "a quantitative expression of the cumulative effect of the investment made over the entire horizon of plan" is negative. This according to EU guidelines is one of the indicators showing that the plan cannot be implemented without co-financing.

Although the plan includes the project regarding the extension of the Metro in Sofia, the CBA for SUMP excluded the costs and benefits related to the metro extension project, due to its dissimilar size and scope. The CBA for the metro is prepared separately and the results are independent for both projects because the investments for the metro construction are significantly higher than these for the other transport modes and the results would not be accurate. However, the results from the conducted CBA for the metro extension in Sofia will be presented in the following chapter. (SUMP, 2019)

8.1.2 CBA for Metro system extension

As just mentioned, the cost benefit analysis for the metro extension was prepared separately from the projects included in the Sustainable Urban Plan in Sofia, even though it is embedded in the plan. In the case of the extension of Metro System in Sofia, the contract was signed by three parties – Sofia Municipality, the Urban Mobility Center as clients and the Metropolitain EAD as operator. This contract was signed after the evaluation of Socio – Economic benefits of the project, which are required for project that are co-funded by European Union. However, the analysis has been prepared by the same consulting company following almost the same

procedure (Kozleva, 2020). The company has prepared the CBAs and relevant application forms for EU grand for several stages of the Sofia Metro System extension. (InfraprojectConsult Ltd, n/d) It includes evaluation of third Metro Diameter, an extension of the first line, construction of the central section.

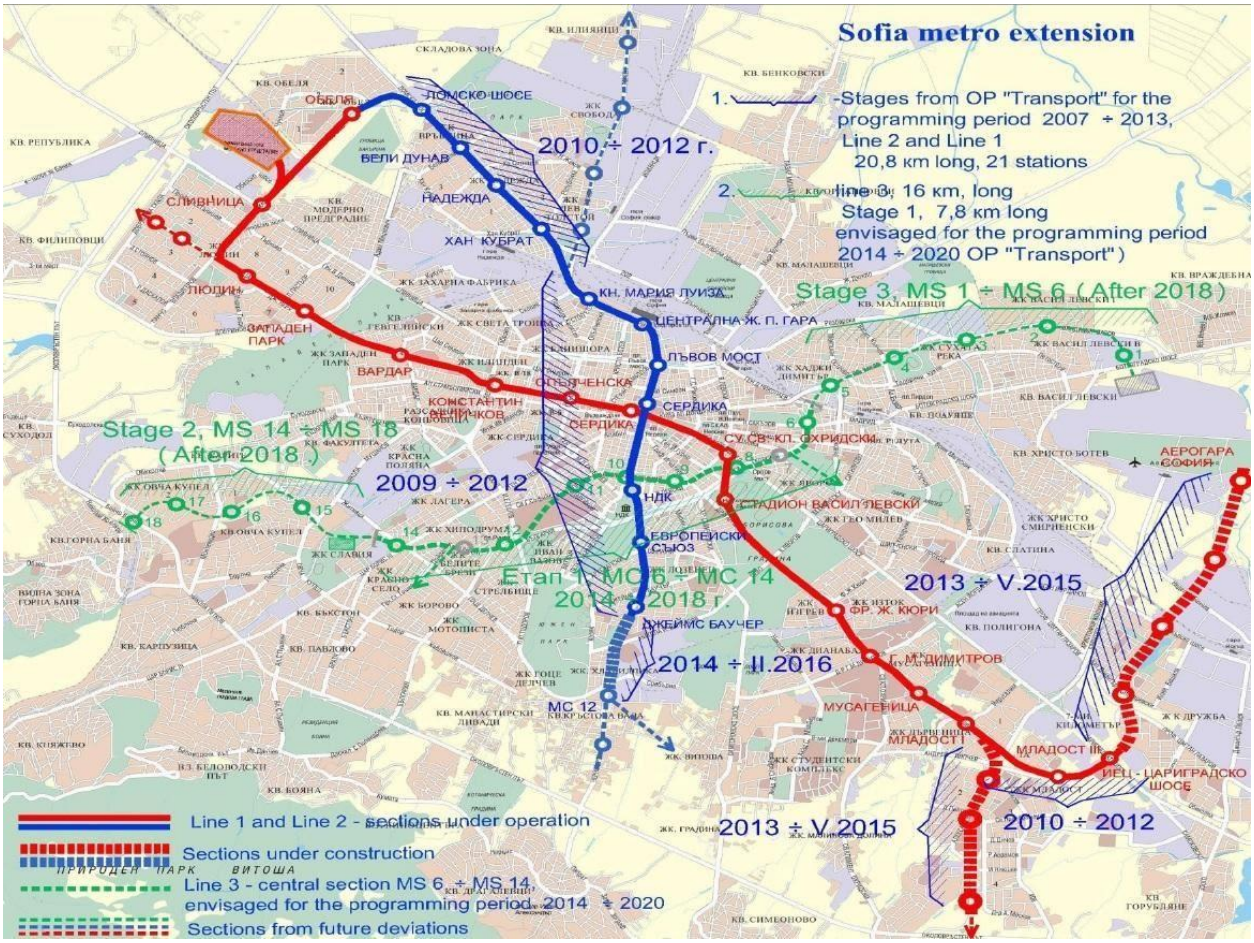


Figure 8: scheme of metro development - up to 2022 (Bratoev, 2014)

In this CBA the parameters that have been included and evaluated are:

- Travel Time costs
- Vehicle Operation Costs
- Accidents
- Emission Costs

The results from the CBA concluded that the total economic benefit from the project of extension of the metro system is evaluated to be more than 1.8 billion euro. In the following

table the total benefits of the project are shown, distributed by the parameters included in the project.

Parameter	Total benefit [pv (Euro)]
Value of time	1 189 857 566
Vehicle Operation Cost	323 562 707
Decrease of Accidents	250 887 131
Decrease of emission costs	44 789 191
Total economic benefits	1 809 096 596

Table 10: Parameters and total benefits for Metro system extension in Sofia (Bratoev, 2014)

In both cases the CBA for SUMP and the CBA for the extension of the Metro System in Sofia, the benefits from saved time represent the largest share of the benefits evaluated in the projects. However, according to the literature that has been reviewed during the preparation of this report regarding CBA, many other important parameters have not been included in the assessment of the costs and benefits concerning the transport implementation in the case of Sofia. This issue will be discussed in the following chapters.

8.1.3 Requirements, preparation and evaluation of CBA in Sofia

In both cases the CBA was prepared in order to get approval for the EU co-financing according the rules laid in the framework of Operational Programs (OPs) of the European Regional Development Fund (ERDF) and the Cohesion Fund, which was proved by the conducted interview with the representative from the company which prepared the CBA (Kozleva, 2020). Although CBA is only one of the requested elements projects to be approved for grand financing, it is interlinked with all other elements and forms required for EU funding. (European commission, 2014).

For both CBA projects about the Sustainable Urban Mobility and the extension of the Metro system, Sofia Municipality hired a consultancy company to prepare the required analyses and documentation. This company as mentioned above is InfraprojectConsult Ltd. The company has experience in the preparation, evaluation, and management of investment projects in field of Energy, Transport, Environment and Water, Regional Development and Mining Sector. Apart from the preparation of CBA for the Modernization and Development of Sustainable Urban Transport in Sofia and Sofia Metro, the Company has worked on Feasibility Studies and

Cost benefit analysis for obtaining a grand under Operation Program Transport and Operational Program Regional Development of several large infrastructure transport projects, including two of the key highways in Bulgaria, Modernization and Development of Sustainable Urban Transport in two other cities - Plovdiv and Ruse, a number of railway rehabilitation and modernization, and the analysis for granting a concession on several of the Bulgarian ports. (InfraprojectConsult Ltd, n/d)

According to Rozalina Kozleva – the manager of InfraprojectConsult, "in practice CBA is equally relevant for private and public projects but because of its focus on social welfare, the method is used for public decision-making and large projects of national importance" (Kozleva, 2020). Moreover, one important factor is that projects of more than 50 million euro can apply for financial support from European funds if they meet the requirements for CBA criterions. Therefore, it is mandatory for the applicants to prepare a CBA. (Kozleva, 2020)

Agreeing with Rozalina Kozleva, CBA "is a very powerful and reliable tool for economic analyses" (Kozleva, 2020). However, "in some cases politicians do not consider these analyses because of commonly used strategies or political attitude." (Kozleva, 2020) The consultancy company prepared the CBA using the European guidelines for Cost Benefit Analysis of Investment Projects and following recommendation from JASPER. JASPER (Joint Assistance to Support Projects in European Regions) is an instrument which supports the preparation of major projects within European regions. JASPER advices cities and regions in order to better "absorb" European Funds. (JASPER, 2007)

According to the European Commission guidelines the procedure of preparing a CBA follows several steps and several actors take part in this process. The managing authority is required to make available information related to the CBA. That information includes models, forecasts of future scenarios and values, results of previous studies, a complete set of data and sources. An independent expert should assess the project based on the provided information and to deliver an Independent Quality Review Report. After that, the managing authority submits a notification of the selected project to the commission services. The European Commission, therefore, assess the project by looking at the Independent Quality Review report and then decides whether the project is approved or rejected. (European Commission, 2014) In the following figure this process is illustrated by showing the main actors in this appraisal procedure in the case of Sofia:

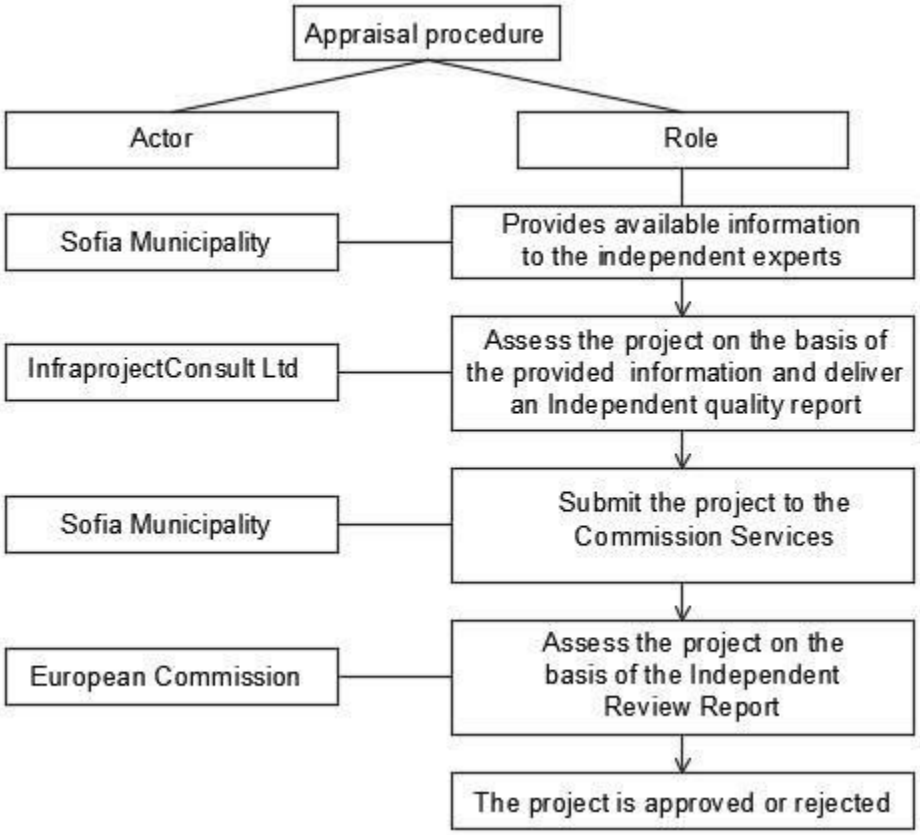


Figure 9: Appraisal procedure in the case of Sofia (European Commission, 2014)

The CBA for any project should meet several requirements in order to justify the need of EU contribution in the face of EU grants. The role of the CBA in the appraisal process and the requirement it must meet are illustrated in the figure 10.

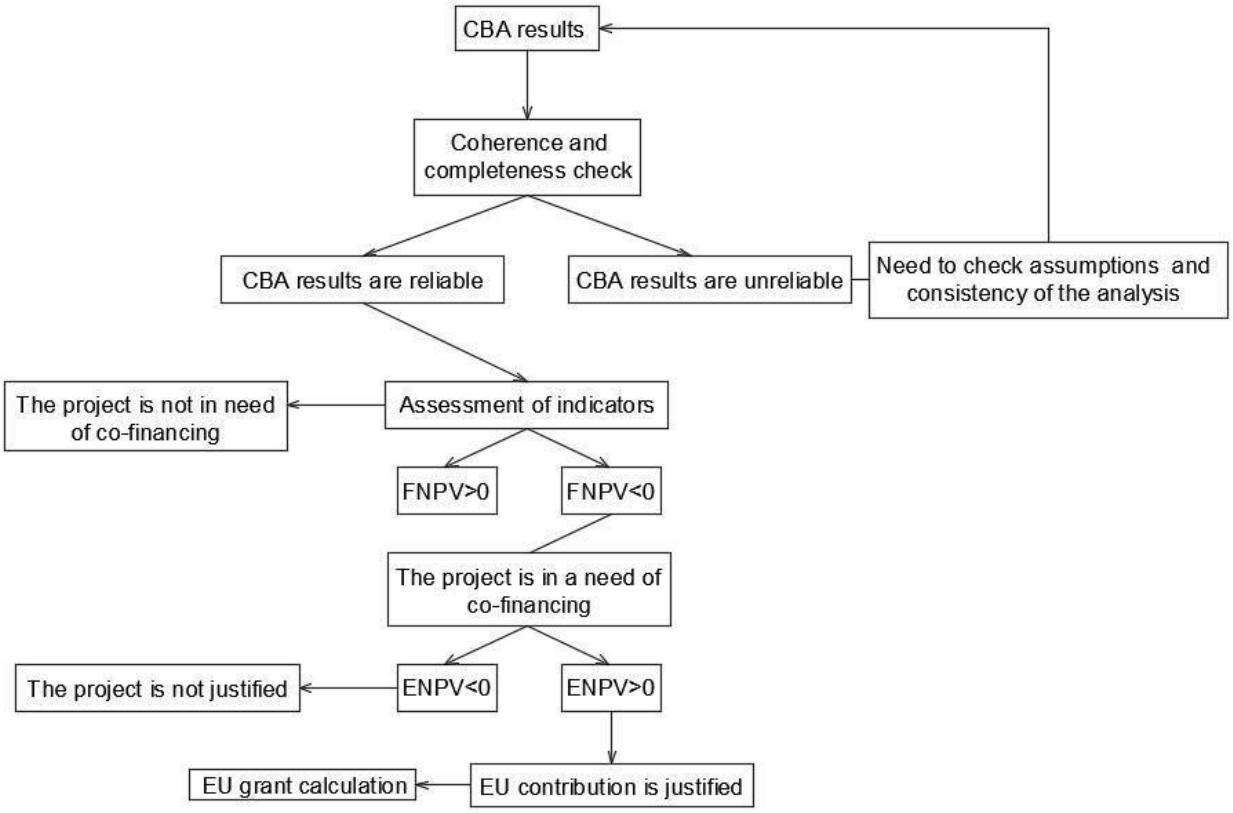


Figure 10: The role of the CBA in the appraisal process (European Commission, 2014)

8.2 The sequence and actors of decision-making processes regarding transport infrastructure in Sofia and the role of CBA

Apart from the main actors who were involved in the preparation and evaluation of the CBA, namely the Municipality and the consultancy company, who prepared the CBA for the Sustainable Urban Mobility Plan and the Extension of the Metro System in Sofia, they were involved many other actors during the preparation of the Plan for the Modernization and Development of the Sustainable Urban Transport in Sofia. As mentioned in section 8.1.1, the plan includes more than 210 separate projects in which many interested stakeholders are involved.

In Sofia the public transport organization is run by the Urban Mobility Center EAD (UMC). UMC is a sole-owned joint-stock company owned by Sofia Municipality. The Company carries out activities related to the analysis, planning, financing, operation, organization, coordination, management, and control of the public transport system. UMC is also responsible for

financing, construction, operation and maintenance of municipal parking lots, garages, and parking spaces. The public transport services in Sofia are realized by three transport operators, which are owned by the Sofia Municipality. The trams and trolleybus transport are operated by the Stolichen Electrotransport EAD. The bus transport is provided by Stolichen Autotransport EAD and the Metro System is owned and operated by Metropolitan EAD.

- Decision making in the scope of the Development of Sustainable Urban Mobility Plan through the lenses of ANT

The contract "Development of Sustainable Urban Mobility Plan of Sofia Municipality" was signed on 07.04.2017, as a result of a successful public procurement procedure and is signed between Sofia Municipality and INFRAMOBILPLAN. The main objective of Sofia City Sustainable Urban Mobility Plan is to achieve a sustainable urban transport system. The plan developed should meet the mobility needs of citizens and businesses in all settlements within the municipality with a view to achieving a better quality of life while covering the period until 2035. The contract is implemented with the financial support of the State Secretariat for Economic Affairs of the Swiss Confederation. (Sofiamobility, n/d)

In the process of decision making regarding the Development of Sustainable Urban Mobility Plan of the Sofia Municipality, several focus groups with the experts were held representing the interested stakeholders. That phase of the project could be defined as the stage of Interessement if we look throughout the ANT lenses. According to Rydan (2016) this is the stage where actors are brought into association with each other and certain relationships are created or strengthened. The focus of the meetings was the discussion of the broad expertise of the project proposals. In these meetings, representatives of various committees took part, as Sofia Municipal Council, Sofia Electric-transport, Sofia Auto-transport, Metropolitan, NRIC, Union of Architects, Union of Urban Planners, API, Independent Experts, Traffic Police and several non-governmental organizations, including NGO's supporting cycling. A key organization in this meeting played Sofproekt as a spokesperson of this meeting. As a result of this meetings new objectives and proposals for solutions were developed and some of the formulated ones were rejected or altered. This stage of the Development of Sustainable Urban Mobility Plan, CBA has been already prepared and presented, however it seemed that it did not play a crucial role as Rozalina Kozleva stated "CBA is good tool for transport project

appraisals but sometimes politics do not consider it, due to other strategies or political visions".

In the next stage the Municipality conducted working meetings with the regional mayors on the territory of Sofia Municipality, as well as wide public consultations. Moreover, according the plan expert meetings with representatives of the Architecture and Urban Development Division of Sofia Municipality was held. The purpose of those meetings was to receive expert opinion and to update systematically the plan. (Sofiamobility, n/d)

According to ANT in the process of enrollment there are actants that are considered as "immutable". As discussed in chapter 6 (ANT), these actors do not alter their relationships and retain their shape and role during the process of translation. In this case such actors could be seen in the face of laws and rules that control the processes of decision making. Such as The Urban masterplan which is the most important spatial development plan of the city of Sofia and Sofia Municipality. It is produced in accordance with the requirements of the Spatial Planning Act but is approved locally and nationally under the Law on the Urbanization of Sofia Municipality. (Sofia Municipality, n/d) According to the interviews this plan has not been updated significantly and now Sofroekt for example aims to alter update and modernize it. (Kolev, 2020)

8.2.1 CBA as a "black box"

In the stage when CBA was already prepared and delivered and the results were calculated and presented, it did not seem that this tool played an essential role in the decision-making process. Looking throughout the lenses of ANT it could be claimed that CBA played a role of intermediator, as it just transferred knowledge. As mentioned, the reason to prepare a CBA for the project of developing Sustainable Urban Mobility Plan in Sofia was mainly to justify the need of EU funding in the scope of the project. It proved that from an economical point of view the project is feasible. However, most of the actors were not familiar with the process and concept which is embedded in the idea of CBA (Markova, 2020). From that perspective the CBA could be considered as a "black box" as it generates results on the base of a variety of inputs, but for most of the actors the process which is carried out in this box is unfamiliar. Within this box details are hidden and the assumption and associations that generate the translation are not transparent. (Rydan, 2016)

Even the purpose of above-mentioned meetings to create new knowledge and to share new ideas by creating coalitions and links between the actors in order to contribute the plan, the links and transferred information between actors is rendered unchangeable. As in many cases regarding urban planning the complex interaction between actants is usually fixed, it could be stated as true for the researched case as well (Rydan,2015). By creating such black boxes, the process of translation is protected by a threat of challenge or instability (Rydan,2015). According to the conducted interviews, many times decisions are made on the base of "narratives or habits embedded in the urban planning". (Kolev, 2020)

In the process of enrollment in the case of creating the plan for developing sustainable urban transport system, one actor took an important part. However, it is important to state that Sofproekt is also owned by Sofia Municipality and as mentioned in chapter 3 (Case of Sofia), this enterprise created the other strategic document which Sofia Municipality uses in its agenda to transform Sofia into livable and sustainable city, namely Vision for Sofia . (Vision for Sofia, 2019)

However, the architect Petya Petrova stated that politicians do not always consider the strategies and plans - "the plans and strategies are put in the drawer and often forgotten"(Petrova, 2020) "Strategies and plans like SUMP do not have a "mandatory character" and sometimes it happens that other laws and regulations are of greater importance". (Petrova, 2020)

Looking at ANT, Sofia Municipality is a key actor as it has a significant role in the distribution of power. Moreover, most of the companies and enterprises that take role in the process of the preparation of SUMP are owned by the Municipality. (Rydan, 2015)

8.2.2 Main actors in CBA for transport project in Sofia

A fundamental point when using ANT is to define the role of actors involved in the studied network. In the following table the main human actors, involved in CBA for transport planning in Sofia and their main activities and role are stated: (Rydan, 2015)

Actor	Activity / role
Sofia Municipality	Administrative body
Sofproekt	Prepare analyses and programs assigned to the framework to the implementation of the "The Urban Masterplan" for Sofia

Urban Mobility Center (UMC)	Analysis, planning, financing, operation, organization, coordination, management, and control of the public transport system
Metropolitan Electric Transport (MET)	Operate tram and trolleybus transport
Metropolitan AutoTransport (MAT)	Operate bus transport
Metropolitan	Operate the Metro
National Railway Infrastructure Company (NRIC)	The railway infrastructure manager in Bulgaria
Road Infrastructure Agency (RIA)	The road infrastructure manager in Bulgaria
Union of Architects (UA)	Represents its members and protects their creative and professional interests afore the state, municipal and international institutions, legal entities, and individuals.
Union of Urban Planners (UUP)	Unite specialists and organizations in a network for exchange of experience and search for solutions of problems of planning, urban environment, and professional development.
InfraprojectConsult Ltd	Consultancy Company
JASPER	Advisors
NGOs	Non-government organization, like cycling organization, organization which aim to improve the urban environment in Sofia
Users	Citizens

Table 11: Main human actors in CBA for transport planning in Sofia (SUMP, 2019, Sofia Municipality, n/d)

According to the actor network theory the planning process includes not only human but likewise non-human actors. In this case, strategies, laws, tools and material structures are taken into consideration. The most important non-human actors and information regarding them is represented below:

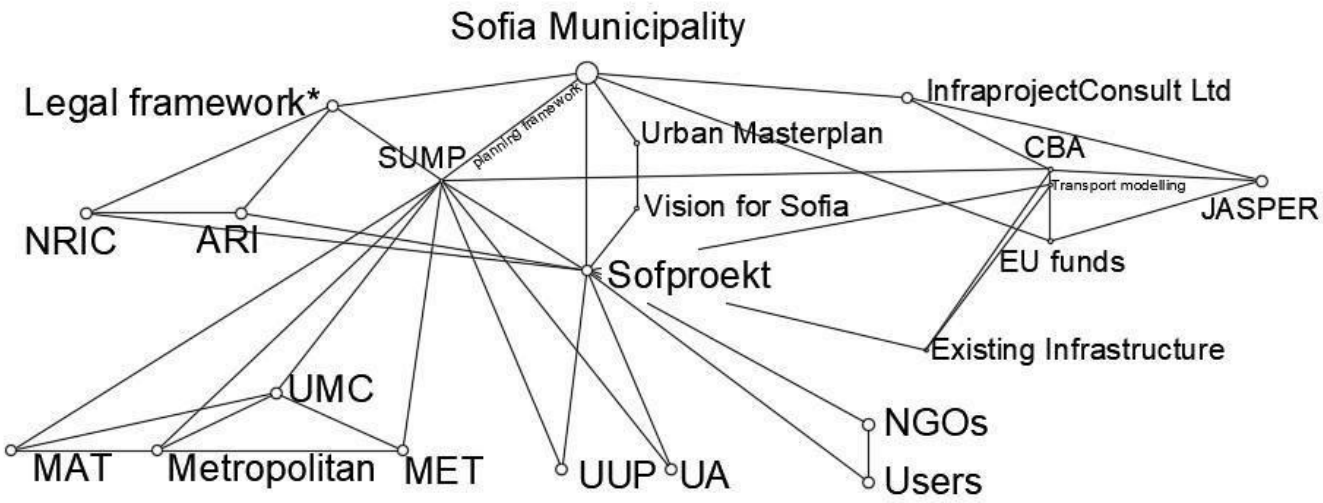
- The Urban masterplan is the most important spatial development plan of the city of Sofia and Sofia Municipality. It is produced in accordance with the requirements of the Spatial Planning Act, but is approved locally and nationally under the Law on the Urbanization of Sofia Municipality
- Spatial development act - provide the public relations, connected with the structure of the territory, the investment designing and the construction in the Republic of Bulgaria, and shall determine the restrictions of ownership for development purposes. Definition of the basic directions and principles of the policy for spatial development and approve decisions for financing the activities for spatial development.
- Vision for Sofia – The most recent strategy for sustainable development in Sofia Municipality
- SUMP – Sustainable Urban Mobility Plan
- Ordinance for organizing the movement on the territory of Sofia Municipality - Regulates the rules, restrictions and prohibitions related to the organization of the movement of road vehicles on the territory of Sofia Municipality.
- Road Traffic Act - the Act settles the rules for traffic on roads open for public use, the requirements for the vehicles participating in the traffic, the requirements for capacity of the drivers, the rights and the obligations of the participants in the traffic and of the respective services and officials, as well as the compulsory measures to be applied and the penalties for violation of the provisions of this Act and of the normative acts issued pursuant to it.
- Territorial development act - comprehensive framework for the development, planning and management of the artificial environment. The Ministry of Territorial Development and Construction shall administer and control the activities falling under this Act, such as urban planning, construction, and public works. The municipalities shall be the local authorities responsible for these matters
- Municipal property act - regulate the acquisition, the management and the disposition of municipal property, unless a special Act provides otherwise.
- Ordinance for organizing the movement on the territory of Sofia Municipality - regulates the rules, restrictions and prohibitions related to the organization of the movement of road vehicles on the territory of Sofia Municipality.

To classify the role of the non-human actors, the following table classifies the non-human actors in this case:

Spatial development act	Legal framework
The Urban masterplan	Legal framework
Vision for Sofia	The most recent strategy for sustainable development in Sofia Municipality
SUMP	Sustainable Urban Mobility Plan
Ordinance for organizing the movement on the territory of Sofia Municipality	Legal framework
Road Traffic Act	Legal framework
Territorial development act	Legal framework
Municipal property act	Legal framework
CBA	Tool
Transport modelling tools	Tool
EU funds	Tool
Existing infrastructure	Metro, trams, bus, trolleybus, bike lanes etc.

Table 12: Non - human actors in the transport planning in Sofia (own design)

According to ANT, it is important to follow and understand the relationships between material elements and social actors. That is why the following graph illustrates an idealized structure with the most important actors who are involved in the CBA network.



* legal framework includes acts and ordinances which were classified in (table xx non-human) actors. This number includes: *Spatial development act, Ordinance for organizing the movement on the territory of Sofia Municipality, Road Traffic Act, Territorial development act, Municipal property act*.

Figure 11: An idealized structure with the most important actors, involved in the CBA network.

From the graph above we can conclude that the most powerful actor in the decisions making process for transport policies is the Sofia municipality. This is also proved by the interviews as Vania Markova states, "The mayor has the most power as she distributes the budget" (Markova, 2020)

From the interview also appeared that even most of the plans and strategies include the development of bike infrastructure, the authorities in charge of the transport infrastructure in Sofia, still neglect the cycling as an equal mean of transport.

"There is a serious incompetence and ignorance for cycling" (Petrova,2020)

As seen from the graph there is no institutions or documents regarding cycling policies in Sofia, which have essential role in the actor network of transport planning and contribution to CBA.

8.3 Analysis regarding cycling in Sofia

8.3.1 CBA and cycling in Sofia

Even though cycling is a part of the plan for developing a sustainable transport system in Sofia, the focus on creating a high-quality bike infrastructure is blurred. The core of the plans is the development of hard infrastructure – e.g. improving the Public transport system and the

extension of the Metro. As mentioned above, the prepared CBAs that this project reviewed exclude bike mode regarding some parameters like travel time. Moreover, according to the literature regarding CBA for transport projects that were reviewed throughout this project, proved that the range of parameters considered in EU transport CBA is limited. In that case many of the parameters that Gossling (2018) proposes as most relevant for any CBA framework have not been included for both of prepared CBAs in Sofia, namely the CBA for SUMP and CBA for the extension of the Metro System in Sofia. The following table shows the comparison of recommended parameters and the ones evaluated in the CBAs in Sofia case:

Parameter	SUMP	METRO EXTENSION
Environment		
Climate change		
Air pollution	X	X
Noise pollution	X	
Soil and water quality		
Land use and infrastructure		
Traffic infrastructure maintenance		
Resource requirements		
Travel time and vehicle operation		
Vehicle operation	X	X
Travel time	X	X
Congestion		
Health, accidents, and comfort		
Health benefits	X	
Accidents	X	X
Safety and dis(comfort)		
Quality of life, branding, and tourism		
Branding and tourism		

Table 13: Comparison in the proposed by Gossling parameters for CBA and the one used in SUMP and for the MetroExtension

The first step in order to prepare analysis is to process comprehensive and complete data. Having accurate and detailed data is an important criterion of doing any kind of analysis. For example, out of all national studies, the data from Denmark is the most regularly updated.

(Gossling, 2018) On the other hand, Bulgaria is lacking accurate data, which was proved throughout the research and conducted interviews. (Kolev, 2020)

For both CBAs, traffic models which provided data regarding transport in Sofia were used, as was mentioned in the previous chapters. Though, the traffic models used in the preparation of CBA did not include active transport modes, due to lack of such (Vitanov, 2020). Another reason is because this transport modes have not been considered as equal to the other options for transportation (Petrova, 2020)

8.3.2 Political issues according the implementation of bike infrastructure in Sofia

As stated, in the strategy document – "Vision for Sofia", Sofia Municipality follows EU politics and recommendation for sustainable urban mobility as promoting the development of cycling infrastructure. In addition, the Sustainable Urban Mobility Plan places the active transport modes as priority in the city, by providing measures to stimulate people to use bikes. The program for the development of bicycle transport on the territory of Sofia Municipality, aims to turn bicycle transport in a significant part of the overall transport system. (Vision for Sofia, 2019)

However, in the case of Sofia, the strategies regarding bike infrastructure are embedded in plans with broader characteristic, e.g. SUMP and Vision for Sofia. According to the report for SUMP, five percent of total budget of the plan is dedicated to cycle infrastructure. This is measured to be 116 million BGN (59 million euro). (SUMP. 2019). However, that budget is not justified with separate analysis for the cycling transport. As discussed in the previous chapters, the CBA for SUMP did not include cycling when evaluating some of the parameters.

The existing independent program regarding cycling in Sofia is "The Program for development of cycling transportation in Sofia Municipality 2016-2019", which period of implementation has expired already and a new one is not developed yet. The program was developed according to an order signed by the Mayor of Sofia. The development of the program is a result of cooperation and participation of representatives from Municipality Council, Department of Architects and Urban Planning, Sofrpoekt and Urban Mobility Center, also representatives NGOs - "Bulgarian Cycling Union". (Sofia Municipality,n/d) However, the targets set in the plan have not been implemented. It was proved both by the interviews and the most recent developed plans and strategies, namely SUMP and Vision for Sofia.

In the beginning of Sofia's mayor mandate in 2016, it was promised that by the end of 2019 in Sofia more than 200 km of bike lanes would be built (Sofia Municipality,n/d). But according to SUMP, the length of bike lanes in Sofia are still only 55.5km (from which big part are not in good condition e.g. bad pavement, with many conflict zones and issues regarding connectivity. (SUMP, 2019)

However, the new plans aim to change this situation. According to the latest survey among 5000 Sofia citizens aged between 14 and 80 years, the share of trips made by bicycle is merely 1.8% and the overall length of bike lanes is 55.5 km (SUMP, 2019). as mentioned in chapter xx Case of Sofia. In line with strategy "The Vision of Sofia", Sofia Municipality aims to make this percentage of cyclist to 10 % and to build 360 cycling lanes, making the total length 415 km by 2028 (Vision for Sofia, 2019). Nevertheless, in the other strategic document, namely SUMP, the newly built bicycle lanes should be 296 km. Moreover, the Municipality aims to provide 280 pieces of new build bicycle stands and to create a system of bike sharing, by providing 2 800 bikes for short term rental. And still the lack of analysis for the costs and benefits regarding the investment for the stated interactions, regarding cycling infrastructure is missing. (SUMP, 2019)

8.3.3 Following the best practices

Considering the best practices around the world it can be assumed that the first step in implementing bike infrastructure and increase the percentage of active transport in daily routines is to create Strategies regarding cycling. For example, the first bicycle strategy in Copenhagen was introduced in 2002 as the "Cycle Policy 2002-2012" and was followed by number of documents regarding cycling plans, like the Bicycle Track Priority Plan 2006 – 2016 and the latest Bicycle Strategy 2011-2025. (Gossling, 2015) Since 2006 the increase of cyclists in Copenhagen is more than 22 % (Cycling Embassy of Denmark, 2017). Moreover, in the case of Copenhagen the Municipality constantly improves and updates its CBA framework, to compare the costs of cars and bicycles.

In order to justify any kind of urban restructuring, including infrastructure development and re-allocation of urban space, such analysis is from essential importance. However, the significance of CBA for cycling has not received much attention in the CBAs in European urban transport neither in the literature regarding cycling. Copenhagen remains the only city that compares the costs of cars and bikes in the its CBA frame, but many others countries

started to consider CBA as a powerful tool, which can provide an excellent basis to evaluate the externalities which transport cause and their costs and benefits (Gossling, 2018)

External costs or externalities of transport are generally not generated by the transport user and hence not taken into account when they make a transport decision. For example, cars exhausting emissions, cause damage to human health, creating an external cost. This is because the impact on those who suffer damage to their health is not considered by the driver of the car when taking the car. Most of the analysis regarding transportation does not consider external costs which affect other users. (European Commission ,2019).

For example, if we look at the overall external costs in Bulgaria created by the transport sector, we can see that the road transport costs the country 6.5 billion Euro yearly, which represents 6.5% of the country's GDP. (European Commission, 2019). According to the report regarding the external costs in EU28, for example, the congestion cost generated by cars in Bulgaria is estimated to be 1.278 billion Euro per year. If this is perceived as an average delay cost in urban areas, then the report suggests that the cost of delay in urban areas in Bulgaria is 8.69 euro/vkm. (European Commission, 2019).

Although many studies have proved the negative effects of motorized transportation, policies keep favoring the automobiles. (Gossling, 2018). As Gossling suggests this is mainly because the true cost of transport modes is systematically underestimated. Although, CBA have various of limitations in the evaluation of transport projects, Gossling states that the importance of CBA can be expected to grow. Many studies proved that the cost of cycling is considerably lower than the cars. This is mainly related to health. The health benefits are positive even in situations where the conditions are not so favorable, such as high levels of air pollution, which is the case of Sofia. (see chapter 3 Case of Sofia)

Although, CBA already have been used in the context of transport in Sofia, it did not include many parameters that have been recommended by Gossling to be used in any CBA framework (see table 11). Moreover, in order to conduct comprehensive CBA, there is a need of explicit and detailed data. In the case of Sofia, the city still lacks such. Though one of the aims of Sofproekt is to gather such data, analyze it and use it. As mentioned before in order to redesign the urban environment, there is a need of significant investments (Gossling, 2018). In the case of Sofia, the CBA was used in order to receive an EU funding in the frame of European Operation Program. This funding contributes to the establishment of most recent

plans for sustainable development in Sofia Municipality. Although the conducted CBA proved the efficiency of the plan for Sustainable Urban Mobility and the extension of the Metro system, this report claims that individual detailed and comprehensive CBA should be prepared to justify the construction of bike infrastructure which is embedded in the Sustainable Urban Mobility Plan. One of the challenges such analysis to be prepared is the willingness of the responsible authorities to require it. According to the best practices in this field the CBA has been used to evaluate the benefits of cycling after certain politics regarding promotion of active transport has been implemented. From all said above there are several steps that can be considered in the case of Sofia. First a bicycle strategy on national level should be considered, followed by specialized and comprehensive plans. In addition to that a detailed and present data should be gathered and examined in order to prepare relevant and complete analysis, which can prove the relevance of bike infrastructure implementation.

9. Discussion

This chapter will discuss the main limitation in the framework of CBA for transport projects. It will look at the opinion of politics about the use of CBA and will review the main advantages and disadvantages of CBA and how could be improved? Moreover, the chapter aim to answer whether CBA can be supplemented by other kind of tools like Multi Criteria Analysis?

9.1 Limitation of CBA

According to Gossling, CBA as a "decision making tool" has weaknesses related to the choice of criteria that are evaluated in the analysis. There are usually issues in the allocation of unit costs and the choice of the most appropriate time span for which the analysis is conducted. Moreover, the common CBA framework often is not able to sufficiently represent double count effects. (Gossling, 2018) The methodology of CBA gives a ratio between the cost and benefits as a result. This ignores the distribution of the considered costs and benefits.

In the traditional case CBA often makes limited contribution to decision making in urban context as the focus is primarily on cars. In that sense, especially in countries where the current transport paradigm still favors automobiles, the CBA framework need to be "updated" in order to include parameters and factors which can appraise the benefits of alternative active transport modes like health benefits, environmental impacts and other externalities related to

cycling and walking. Another criticism for CBA is that this analysis value mainly impacts in economic terms and lack transparency and public participation.

One more important issue considered in the framework of CBA is the data analysis. In context where there is a lack of data (which is the case of many countries with short or no CBA tradition, like Bulgaria (Gossling, 2018), it is very difficult to find and estimate monetary values for the analyzed parameters and providing conclusions makes it thus unrealistic.

Eda Udstaglu states that there is a need of wider scope of evaluating the transport projects in order to cover externalities of transportation which are often not included in the common CBA. The main argument for that is the fact that main economic benefits in the framework of CBA is usually represented in travel cost savings. As it is the case of CBA prepared for Sofia. (Ustaulglu, 2019)

9.2 Political opinion of CBA

Considering the fact that CBA can influence decision making it is important to understand how this tool is used by politicians and what is their opinion about this appraisal tool. According to D.W. Pearce (1999) there is still a gap between preparing CBA and how CBA affect actual policy decision. A study from The Netherlands related to politicians' perspective in transport policy appraisal reveals some interesting results. According to this study and politician's opinion CBA is a useful tool, but the main issue of the method is that the result is not decisive. For example, CBA is not able to consider subjective value like livability. In addition, non-monetized items are treated unbalances, such like climate change, and environmental impacts. The most common disadvantage is that CBA cannot include every impact and some effects cannot be expressed in money. D.W. Pearce (1998)

One of the most criticized issues in the methodology of CBA is its lack of transparency. According to Jan Annema (2015) "CBA shows what the people in power want". And CBA is not reliable tool because often the party in charge manipulates the input. Although the CBA can be used to improve or prioritize projects, at the end "the decision is political". (Annema, 2015)

In the study of the politician perspective in transport projects appraisal four main points have been indicated as common disadvantages of CBA. Firstly, CBA information is not decisive. The Net Present Value is not always complete. Therefore, the politicians are more interested in the

clear notion of the trade-offs. As mentioned above many of the politicians find CBA to be non-transparent. Therefore, an improvement of CBA methodology is suggested. (Annema, 2015)

9.3 Can CBA be supplemented by other kind of tools like Multi Criteria Analysis

Among all the methods for assessing transport projects, CBA has the biggest use in the national appraisal frameworks across Europe and internationally. Although CBA can include a large set of parameters, like socio-economic impacts, transport network effects, energy and environmental impacts within the transportation system, CBA is not always the best method for project evaluation in every single case. That is explained with the difficulties to give a monetary value for the assessed parameters and existence of objectives which are not always related to economic efficiency. That is why in some cases different approach is used to complement or replace the CBA. (Udstaglu, 2019)

CBA is a tool which appraises the efficiency of the policy. On the other hand, MCA is a set of decision-making methods which are based on the evaluated alternatives with a respect to a number of criteria. (Annema, 2015)

According to Eda Udstaglu (2019) there is no best methodology for evaluation of transport projects. A wide variety of methods is used to assess transport policy impacts. These methods depend on the nature of objectives and the characteristics of value judgement. Within the international literature regarding transport impact evaluation, a various approach can be found. That range of methods include economic analyses as Cost benefit analysis, Cost effectiveness analysis (CEA) and life cycle cost analysis. In addition, transport projects can be assessed through specific methods as Multi-Level Criteria analysis (MCA), social and environmental based analysis like Environmental Impact Assessment (EIA) and Strategic environmental assessment (SEA), decision analyses and other specific approaches like simulation/mathematical modelling, land suitability analysis, etc. (Udstaglu, 2019)

Complimenting CBA with Multi criteria analysis (MCA) is a common practice in many European countries. The advantage of Multi Criteria analysis is that this methodology can incorporate criteria and factors that are not easily expressed in monetary values. However, this tool can be too subjective as it is based on decision makers' and experts' weighting of the project impacts. (Annema, 2015)

As mentioned in chapter 4 (CBA) in the beginning of the 2000s the government of the Netherlands took the decision to make CBA mandatory to support decisions regarding large transport projects. An MCA was also considered to become required for transport policies, but that proposal was declined due to two reasons. The basis for the assigned factors is considered to not always be clear. Also, a double effects counting is possible because the MCA do not embrace a strict criterion for the inclusion of evaluated effects. However, the question whether the CBA is the best appraisal tool for transport projects still exists. The literature regarding that question often investigates whether CBA is an appropriate tool in the appraisal process of transport projects and whether another tool like MCA should replace it, or a combination of both is the best. (Annema, 2015)

According to Jan Annema (2015) the main advantage of MCA is that this method is able to incorporate criteria which are usually difficult to quantify, like environmental and social issues.

9.4 Improved CBA for cycling

As was stated in chapter 4 (CBA), the CBA for cycling are still rare. In addition, more of the parameters included in the regular CBA methodology do not evaluate the externalities that are the most significant for active transport modes. These externalities as mentioned already in this report should include climate change, air and noise pollution, health, accidents, perceived comfort, etc. Moreover, when the range of parameters is stated explicitly, a comparative approach to CBA can be considered as a good tool in decision making processes. The comparative CBA can be used especially in context where transport modes compete for space and priority for financing. For examples, as cars cause most of the air and noise pollution it could be argued that cars contribute to the health issues of the society. However, within the literature regarding CBA the only comparative study of costs for cars and cycling is presented in Copenhagen context. This study was discussed in chapter 4 (CBA). (Gossling, 2018)

Since the CBA prepared in Bulgaria used European guidelines for evaluating transport projects, which do not include evaluation of projects regarding cycling this paper suggests that the guidelines should be updated.

Although the main advantages and disadvantages of the CBA were explained in the chapter so far it is important to mention that these conclusions are based on countries where CBA is a common practice in decision making process. However, in Sofia case and in general in Bulgaria there is a lack of literature regarding the use of such appraisal tools and how

politicians use them in decision-making concerning transport policies. Therefore, in cases such Sofia where CBA is not considered in the practice in decision making processes, this knowledge can contribute to the use of "updated" CBA and not repeating the usual mistakes. Therefore, in cases like Sofia it is important to look at the best practices and consider the issues that are already appeared in the previous practices.

10. Conclusion

Although a CBA was used to evaluate the Development of Sustainable Urban Transport Plan in Sofia, this paper propose that the CBA framework should be updated. It should consider active transport modes and its benefits in order to provide a basis for better decisions.
The analysis of this paper meant to present the importance of CBA for cycling and to examine its connection to the decision-making process in Sofia by using the lenses of "Actor Network theory". Even though, CBA is not a common practice within the framework of planning policies in Sofia, this tool can be considered as very powerful in the future if the city desires to transform its transport system towards more sustainable one. The transport policies in Sofia have been changing their direction into more sustainable direction as following the best practices from Western countries (SUMP. 2019). This have been achieved as creating new plans and strategies focusing on the sustainable agenda, which used CBA as a tool to prove its economic and social feasibility.
However, as many scholars state, the current CBA framework is limited and often underestimate the costs of cars and benefits of bikes (Gossling, 2018). The main reason for that usually is the selection of parameters evaluated in the CBA. Moreover, to conduct a comprehensive and accurate CBA for any transport project, there is a need of accurate and detailed data for the current transport system. (Gossling, 2018).
Throughout the research, it was proved that in the case of Sofia the cycling and its benefits was neglected in the preparation of CBA for the Sustainable Urban Plan. Therefore, the possible benefits of cycling in Sofia are still not recognized. The aim of this report is to prove that if there is a relevant study, which could show the economic feasibility, this could change the political attitude and influence the responsible authorities to invest in infrastructure which would favor active transport modes.
However, one of the issues in the case of Sofia in the process of implementing transport policies is the fact that decisions are taken on a way that Actor Network Theory explain as a

"black box" (Rydan, 2015). The connections are very stable and changes in the current network are rarely accepted. However, in both cases of CBA in Sofia which were examined throughout this report, the analysis proved the feasibility of the projects and appeared to be a key actor in the decision making. By opening the "black box of CBA in the case of Sofia, many omissions have been assumed, comparing to best practices across Europe. This on one hand is due to the methodology of commonly used CBA in European context, and on other the lack of transferring data and knowledge in the network of CBA in Sofia.

Looking at the best practices, in countries where a comprehensive and explicit CBA for cycling are prepared, this analysis has been preceded by significant experience regarding cycling. That is why this report suggests that the first steps to shift the transport paradigm favoring cycling in Sofia is to introduce a strategic document supplemented by detailed and comprehensive CBA, including wide range of parameters to better understand the consequences of investment in cycling. In that sense CBA for cycling can play an important role as a "mediator" by proving the socio-economic benefits of investing in bike infrastructure.

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11.2 Interviews

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Transport engineer in Sofia Municipality

Vitanov, A., - Email communication
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