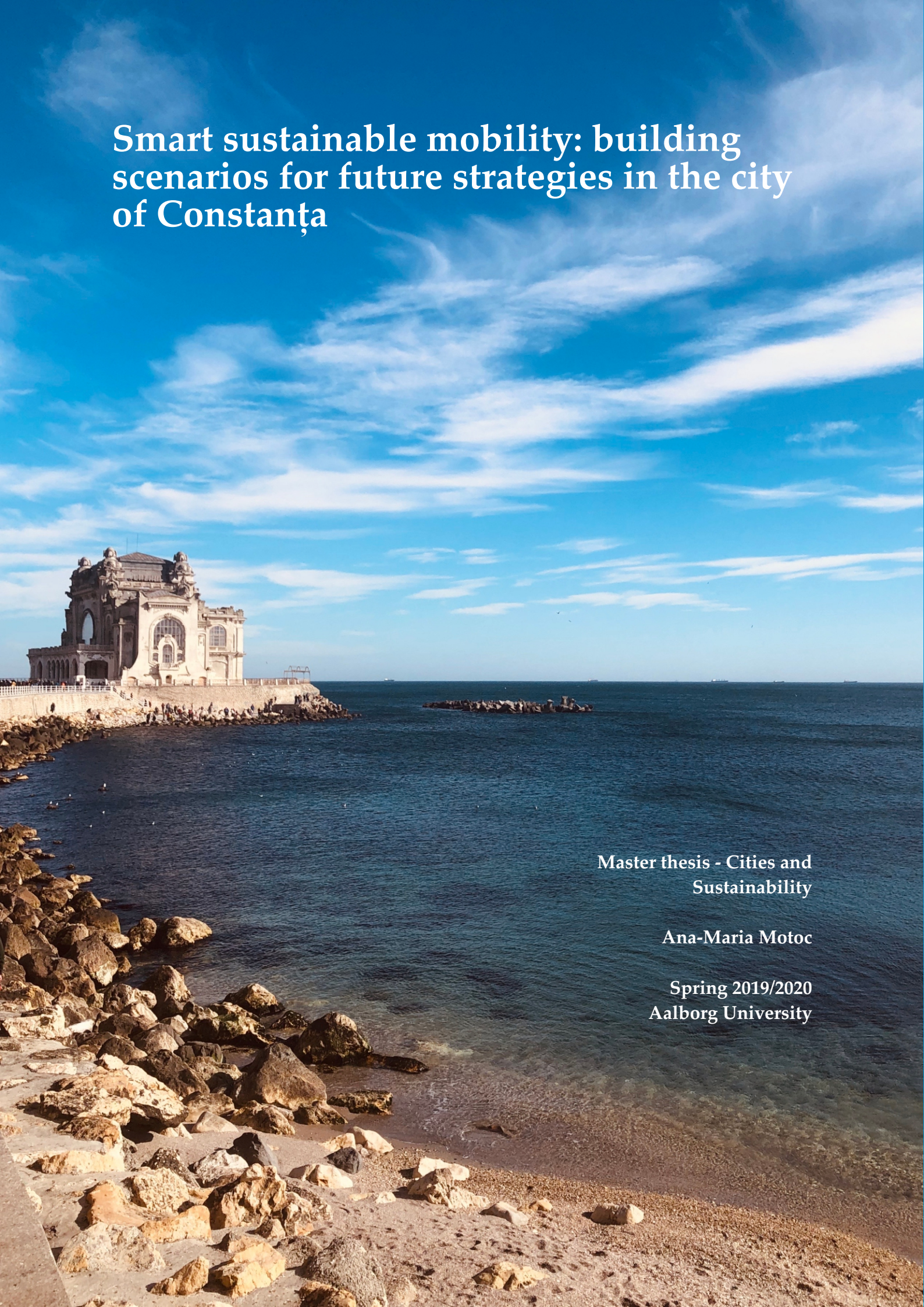
Smart sustainable mobility: building scenarios for future strategies in the city of Constanța



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COVID19 and the consequences of the lock-down of society and the university since March 13, 2020 have had influence on which activities that have been possible to stage and carry out as part of the project work. More specifically, this means that activities have been limited to online activities, and that activities such as Lab activities; surveying activities; on-site ethnographic studies and on-site involvement activities have not been possible.
When assessing this project, please bear this in mind.

Own reflections on the experienced challenges

The COVID19 pandemic has had a significant impact on my research. Firstly, I have conducted my thesis in my home country Romania, where the situation has been more advanced than in Denmark, with harsher measures being taken by the government, leading to lockdown and the impossibility to move between cities. As my residence is in the capital city of Bucharest, it was impossible for me to make field observations and face-to-face interviews, as I have initially planned for data collection. Furthermore, the context made it harder even for online interviews to be made, as Romanian city officials are usually more reluctant to using digital platforms. Nevertheless, this was also hardened by a lack of time from their part as their schedules were busy with pandemic-related issues. All of these factors have led to a shortening of available data, calling for constant adjustments to the research process, which have taken a significant share of the given timeframe. Overall, the COVID19 pandemic has provided a set of barriers that I have managed to overcome to the best of my abilities, considering the given context.

Reading guidelines

The following paper is elaborated under an article format and follows the template and guidelines of the Sustainability Journal, which can be accessed at the following link: https:// www.mdpi.com/ journal/sustainability/instructions. The article is structured in sections and sub-section accordingly, with all visual elements being numbered in order of appearance. The latter can be simply identified in the Table of Figures located at the end of the article, preceding the References section. The two Appendixes include additional information relevant for the research conducted, but which, for formatting purposes, could not be included in the main article, such as interview guides, questionnaire outline or additional figures.

In terms of citation, Harvard has been used as a referencing style and a complete list of used references can be found in the References section at the end of the article.

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Article

Smart sustainable mobility: building scenarios for future strategies in the city of Constanța

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Abstract: There are worldwide approaches to shifting mobility towards more sustainable practices, with various urban actors being concerned with the negative effects that current mobility trends have on the socio-economic system and the environment. Technology and data use have become popular tools for obtaining sustainable mobility, with discussions of the smart city being broadly promoted. Much less attention is being paid to the correlation between the two, especially when it comes to more active means of transportation. The purpose of the study is to outline how scenario building can help achieve smart sustainable mobility and enhance future strategies for cities. Using statistical data, a questionnaire and interviews, the article elaborates on three scenarios for the case study of Constanța to understand how this approach can be useful for future mobility planning. Results show that scenario building can be an effective instrument for planning at the city level, as it provides broad expertise, promotes participatory planning and helps sustain an integrated approach to mobility. The process needs to be supported by a series of actions to improve the municipality's capacity in terms of planning and to align its goals to those of smart sustainable mobility.

Keywords: sustainable mobility, smart mobility, scenario building, mobility planning

1. Introduction

Rapid urbanisation has been one of the main concerns of practitioners and policymakers for the past years. As of 2018, 74% of Europe's population lives in urban areas, with a projected 83.7% percent for the year 2050 (European Commission, n.d.). Urbanisation comes with a set of challenges, from managing and providing services (transport, water, waste, energy), as well as with sprawl and the development of peri-urban areas that imply higher costs for developing the right infrastructure. In addition to this, the increase in the number of people living in urban areas contributes to higher levels of pollution and consumption, aggravating the effects of climate change (UN, 2018). Various organisations, professionals and cities have taken on the challenge to reduce the negative effects of urban areas and to ensure good planning for cities in order to minimize their impact. All of these considerations are made in accordance with reaching sustainable development and follow the targets of Agenda 2030 and the corresponding Sustainable Development Goals (SDGs). Under these circumstances, new forms of scenarios for the future are required that include a holistic way of thinking to minimise the negative impact of cities.

One of the main domains addressed in this discourse is the one focusing on urban mobility. The goal is to provide safe, equally accessible and affordable mobility to all citizens and to ensure that citizen movement has a minimum to no negative impact on the environment (UN, 2018). To achieve this, several academics have been promoters of the sustainable mobility paradigm that focuses on more active means of transportation such as public or non-motorised transport as an alternative to the car, which is considered to be one of the most unsustainable means of transport (Makarova, et al., 2017). In the current context of the COVID19 pandemic, cities around the world are taking urgent measures to provide cleaner and safer mobility options for citizens to prevent the spread of the virus and minimise its impact (Connolly, 2020; Huet, 2020). Citizens welcome new ways of moving around

the city, with a considerable increase in the number of people choosing to cycle during the pandemic (Lindsey, 2020). This becomes highly relevant as discussion around post-pandemic urban mobility contours the need for cities to shift away from the car in favour of walking and cycling policies that could ensure social distancing measures are kept and that safety and citizen health become priorities in a post-crisis context (Vandycke, 2020; UNECE, 2020).

Discussions on the concept of smart city have outlined the possibility to use technology and data as an assisting instrument to achieving sustainability in the city, with mobility being one of the main pillars of the concept (Lyons, 2018). However, both sustainable mobility and smart mobility are concepts that are not clearly defined and more than often the two terms are used following the context, rather than focusing on a more general framework. This ambiguity has led to outlining two separate paradigms, while in reality, the two show similar characteristics. More recently, the discussion is being shifted towards an integrated use of the two concepts, with several academics addressing the need for both smart and sustainable mobility as a unitary approach (Lyons, 2018; Silva, et al., 2018).

Against this background, the present research aims to add to the subject by focusing on understanding how the concept of smart sustainable mobility is being contoured and how it can be approached. In this sense, the article takes on a case study research approach, aiming to understand how the concept of smart sustainable mobility can be framed under a design-oriented scenario framework to be applied in a concrete situation, namely in the city of Constanța, Romania. The theoretical framework, thus, builds on two main concepts, namely smart sustainable mobility and scenario building. The first comes as a correlation between the concepts of sustainable development and smart city, with consideration being given to an existing popular approach to technology in the city, while the second targets a relevant planning instrument that can be used in the process of developing mobility systems smartly and sustainably. The outcome of the research is a set of possible configurations of scenarios for smart sustainable mobility that can contribute to shaping future planning strategies for the city of Constanța. The results developed through scenarios for 2030 take into consideration three types of situations: 1) Business as usual, illustrating the situation in 2030 following current trends, 2) Shifting work-home-work commuting, presenting the situation of using alternative means for transport for the most common type of commuting patterns in Constanța and 3) Promoting non-motorised transport, showcasing Constanța encouraging and promoting the use of cycling and walking. These are accompanied by some recommendations for the municipality targeting the general approach to future mobility planning.

The article will follow by presenting the methodological considerations of the research, followed by a brief presentation of the chosen case study. Section 4 will then focus on the main theoretical framework behind the conducted work in the form of the two main concepts – smart sustainable mobility and scenarios, as well as the implications and correlations of the two. The paper will continue by outlining Section 5, accounting for the analysis and focusing on presenting the three development scenarios for the city of Constanța and Section 6 shaping the discussion around the relevance of scenario building in relation to the case study, as well as the identified list of recommendations. The article then goes on to conclude and answer the research question, outlining the most important aspects of the work. Lastly, an overview of future research is portrayed.

2. Methodology

The article uses case study-based research to illustrate how scenario building can drive change for future strategies and become a means for discussion among stakeholders in a concrete situation (i.e. the city of Constanța). This is a common type of research in the field of social sciences and is considered to be one of the successful approaches as it offers a context-related, more detailed analysis of a singular case. This allows for a more in-depth analysis, touching upon subjects that could otherwise be redundant for more general research (Flyvberg, 2006). The knowledge generated from

analysing an individual or a small set of cases can then be scaled up and applied in comparable situations that imply the use of similar concepts. Nevertheless, it is essential that the case study used for research is representative of the chosen topic and can provide fruitful input that can add to the existing literature (Flyvberg, 2006). Drawing from this, the relevance of choosing Constanța as a case study lies within its current status as a city in transition from a mobility point of view (Stadler, 2020), where the necessity for effective future planning is becoming evident in relation to the challenge of attaining smart sustainable mobility.

To develop the current paper, a mix of qualitative and numerical research was conducted, based on the concept of smart sustainable mobility and the implications of scenario building as a suitable method for attaining its targets. Both quantitative and qualitative methods were used, with statistics, as well as surveys and interviews being realised to contour a broad overview of the case study. The research portrays an epistemology and an ontology based on pragmatism, meaning that the reality is constantly changing and it can be challenged all the time, with no one fits all solution for problems, but rather a context-based approach, where the adequate solution is the one that builds on contextual circumstances (Patel, 2015). The research also bases itself on critical realism, taking into account that the world exists regardless of individual knowledge and to understand how certain events work, the underlying contexts of said events need to be identified. This is further emphasized by using the concept of scenarios, thus acknowledging multiple future alternatives that need to be considered, while at the same time recognizing that external factors play a crucial role in their completion (Næss, 2015).

In this regard, a research question has been posed in an interventionist way to guide the research process, which combines the theoretical framework with the identified problem formulation relating to the city of Constanța. The research question is as follows:

"How can scenarios for smart sustainable mobility enhance new urban strategies for the future of Constanța?"

The research question is supported by three sub-questions, as follows:

- *How can scenarios for smart sustainable mobility be defined?* – This sub-question shapes Section 4 – Theoretical framework and focuses on defining the main concepts used throughout the research;
- *How can scenarios for smart sustainable mobility be built for the case of Constanța?* – This sub-question accounts for Section 5– Analysis and comprises the scenarios identified for the city of Constanța;
- *How can scenarios be a means of evaluations for future planning choices related to smart sustainable mobility in the city of Constanța?* – This sub-question is answered in Section 6 – Discussion and presents the implications of the identified scenarios, together with recommendations for future mobility development that targets the authorities of Constanța.

To answer the above-mentioned research questions, a range of predominantly qualitative methods were used. Firstly, an extended literature review was carried out, focusing on academic writings, best practices and municipal documents and studies. The academic writings in the form of articles, book chapters and studies, contributed directly to the theoretical framework section and to outlining the main concepts of the paper. These were retrieved through academic platforms such as AAU Library and Google Scholar and recommendations made by the supervisor. The best practices have been used to showcase the practicality of smart sustainable mobility as it has been successfully portrayed in various cities worldwide. They have been selected as a result of their relevance for the research both in terms of topic and similarity to the case study of Constanța. The official documents pertaining to the municipality have been consulted to understand the context of the city in terms of urban mobility, as well as to identify the plans for future development in this field. These have also

contributed to the construction of the problem formulation and they were accessed from the official websites of the municipality, the metropolitan area and the CIVITAS PORTIS project.

For building the scenarios a mix of qualitative and quantitative methods has been used to collect and analyse the relevant data. Hereof, an online questionnaire was created on the free platform Google Forms to collect the citizens' opinions concerning the current mobility system, as well as their opinion towards smart sustainable mobility. The questionnaire was distributed through social media platforms (more specifically Facebook) to relevant groups from the city of Constanța, such as general city groups, civic groups, biking groups, etc. It was made available for two weeks and has received 139 answers. The questions targeted general information on the respondent (i.e. age, gender), their mobility patterns, their opinion towards the state of the current mobility system and the degree to which they use and would use digital services for mobility. Furthermore, the respondents had the possibility to outline any other issues they saw fit in a separate comments section. A full outline of the questionnaire can be found in Appendix B.

In addition to the survey, two semi-structured interviews were conducted to collect qualitative data to support the scenarios. The interviews were conducted digitally, using the Webex platform and the full interview guides can be found in Appendix B. The first interview was with Adrian Crăciun, the Coordinator and Spokesman of the Strategy and Development Programs Department for the Cross-community Development Association Constanța Metropolitan Area. The department is responsible, among others, for outlining the relevant strategies including the Sustainable Urban Mobility Plan and the Integrated Development Strategy. The list of questions was outlined before the interview and was sent to the interviewee beforehand. These were related to the strategic approach that Constanța has both at municipal and at the metropolitan level, as well as oriented to understanding the current problems and the challenges the authorities have been faced with. The second interview was with Reinhold Stadler, project manager and mobility expert at CIVITTA Romania, the consulting company in charge of developing the Smart City Strategy for Constanța. The list of questions addressed to Mr. Stadler focused on his expertise in the mobility field, as well as on his experience in analysing the situation of Constanța.

To better support the outline of the scenarios, quantitative data related to mobility and the demographic profile of the city was collected as the starting point for the forecasts elaborated within the three scenarios. This data was retrieved as raw data from official sources such as the online database of the National Institute of Statistics – Romania, existing strategic documents and studies for the city of Constanța, as well as from the official websites of the municipality and the metropolitan area and was processed by the author to aid the analysis process. Each of the calculation methods is provided in the form of a footnote to ensure transparency and accuracy.

3. The case study: Constanța, Romania

The case study used for this research is the city of Constanța, showcasing the mobility situation of a medium-sized city located in Romania. Constanța is part of the South-East Region and the county seat for the county bearing the same name (i.e. Constanța). With a total population of 311,374 people, Constanța is Romania's 5th largest city (National Institute for Statistics - Romania, 2020). The population has declined considerably in the past 28 years, accounting for 9.5% fewer citizens in 2020. Furthermore, the city follows a pattern of an ageing population, with more than 19% of the total population being over 65 years old (National Institute for Statistics - Romania, 2020). Constanța was initially developed as an industrial city, with several industrial and logistic areas still being active in the present. The most notable such facility is the Port of Constanța, which is the largest port at the Black Sea, as well as in Romania and the 22nd largest in Europe in terms of goods carried (Eurostat, 2018). The port contributes significantly to the local economy, representing one of the main economic pillars together with the hospitality industry and the tertiary sector (CIVITAS, n.d.).

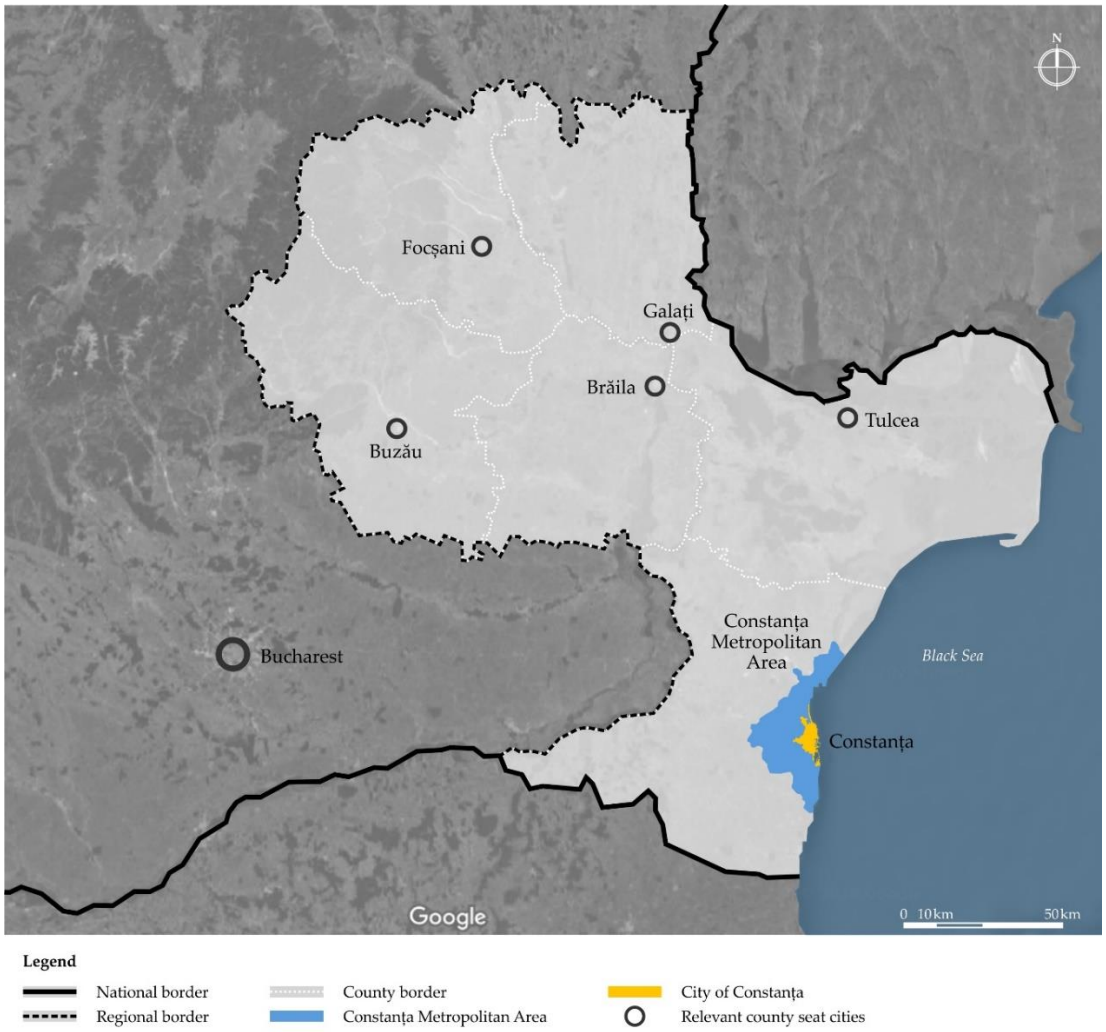

Figure 1. Localization of the city of Constanța at the regional level and in relation to the capital city of Bucharest; own map creation, with base map retrieved from Google Maps.

Located on the western coast of the Black Sea, Constanța is one of the important touristic destinations of Romania, attracting more than 600,000 tourists in 2019 (National Institute for Statistics - Romania, 2020). This is due to the access that the city has to the coastal area featured with beaches that are freely accessible to the public. The city also has in its administrative jurisdiction the most popular Romanian seaside resort, Mamaia, located in the northern part of the city. Due to the high number of tourists choosing this destination, during the summer months (i.e. June, July and August) the population of the city increases by 20 to 35% percent[1].

In terms of accessibility, Constanța is served by an international airport, Mihail Kogălniceanu International Airport. However, the airport has seen a drop in the number of routes as of 2018, in the present only having flights towards two destinations: London and Istanbul ("Mihail Kogălniceanu" Constanța International Airport, n.d.). However, the good connectivity between Constanța and the capital city of Bucharest (see Figure 1), offers access to the biggest airport in the country, Henri Coandă International Airport that offers around 80 routes towards national, European and international destinations (Bucharest Airports, 2016). The distance to Bucharest can be travelled in 2h by car and 2,5 hours by train. The rail line between Bucharest and Constanța is one of the fastest in the country, ensuring good access for a high share of the national population to the sea-side areas.

[1] Own calculation based on the data retrieved from the online database of the National Institute of Statistics – Romania (National Institute for Statistics - Romania, 2020).

Constanța is the biggest rail node located on the coastal area and ensures further connections to other seaside cities and resorts located on the Romanian Black Sea coastline (CIVITTA, 2020).

Looking at the local mobility system, Constanța is a city in transition (Stadler, 2020) which has an understanding of how the mobility paradigm has shifted towards more sustainable approaches but has limited interventions in this sense. In the present, Constanța is a car-oriented city. This is portrayed through the modal share, with the highest share of trips being made by car (27,75%) (WSP/Parsons Brinckerhoff, 2015), as well as from the rapidly increasing stock oh vehicles and motorization rate[2]. The number of owned vehicles increased by 15.1% between 2011 and 2017, while the motorisation rate faced on average a 3.3% annual increase in the same period, accounting for 343.6 vehicles/1000 inhabitants in 2017[3]. The considerable number of vehicles put a lot of pressure on the existing infrastructure and negatively impact the environment through a high share of noise and air pollution associated with car use. These effects are augmented during the summer season, as a high share of the tourists chooses to visit the city and the seaside resorts by car (WSP/Parsons Brinckerhoff, 2015).

In terms of public transport, the city is served by a bus network, operated by both public and private operators. The public operator CT Bus runs 18 permanent and 2 temporary lines, available only during the summer season, while the three private operators manage an additional 9 bus lines. Some of the main issues identified with the public transport service are the relatively low level of integration between public transport and other means of transport, the lack of accessibility for people with low mobility (e.g. elderly, disabled, parents with strollers, etc.), the low coordination between public and private operators, as well as the degraded state of the bus stations (WSP/Parsons Brinckerhoff, 2015; Crăciun, 2020). This lowers the attractiveness of public transport and leads to citizens using their car as the main mean of transport. This is also due to the lack of dedicated bus lanes to ensure faster travel, leading to the same or even higher travel time by using the bus. Looking at average travel times during rush hours, a trip from the train station to the city centre (approximately 3 km) takes between 7 and 14 minutes by car, while the bus takes between 26 and 32 minutes, including the walk from the bus station to the city centre[4].

One of the most pressing issues of the current mobility system lies within non-motorised transport (i.e. walking and cycling). The pedestrian infrastructure is in a precarious condition, especially when it comes to the sidewalks that are degraded and/or occupied by illegally parked cars. However, despite the shortcomings, walking is still one of the popular modes of transport in Constanța, accounting for 26,49% of the total trips (WSP/Parsons Brinckerhoff, 2015). The cycling infrastructure is reduced, with only 2 bike lanes located in the entire city, summing up approximately 6,2 km distributed as follows: 5 km on the promenade in Mamaia and 1.2 km in the city centre (CIVITAS, n.d.). As of 2019, the city has implemented a bike-sharing scheme, making available 390 bicycles concentrated in 24 stations. However, the stations are mainly located towards the coastal part of the city, with the service being available only from the 1st of March to the 1st of December and requiring some bureaucratic procedures to obtain a card that allows you to use the bicycles (CT bike, n.d.). Furthermore, the lack of proper cycling infrastructure leads to the service not being used at its full intended purpose and potential, but rather for recreation and touristic purposes. This is also illustrated in the modal share of Constanța, with only 0,58% of the trips being realised by bike (WSP/Parsons Brinckerhoff, 2015).

To overcome the above-mentioned issues, several projects have been implemented or are in the process of implementation. These include the rehabilitation of several main arteries in the city to include dedicated bus lanes, bicycle paths and improved sidewalks for pedestrian movement, the

[2] The motorisation rate is the number of registered vehicles per 1000 inhabitants.

[3] The only data available at the municipal level is for the years 2011 and 2017 (Constanța Municipality, 2018). This is due to the fact that in Romania vehicle registrations are calculated at the county level.

[4] The data has been measured during workdays (Monday-Friday) and rush hours, namely at 8:00 AM and 5:00 PM on the Google Maps platform.

extension and modernisation of the municipal public transport fleet by purchasing higher standard buses[5] and the rehabilitation and pedestrianization of several streets located in the city centre (Constanța Municipality, n.d.). The scope of these projects is to reduce the environmental impact of transport in the city and to promote alternative, more sustainable means of transport. They are expected to be finalised by 2022 and are financed through European funds (Constanța Municipality, n.d.). In addition to these, the city is part of the CIVITAS Portis project alongside four other European cities, a project that focuses on enhancing sustainable mobility in port cities. This is done through using a living lab approach, where several initiatives and pilot projects are tested to support sustainable mobility development (CIVITAS, n.d.). Among the most important measures taken by Constanța within PORTIS lies the Urban Mobility Forum, where various stakeholders (municipality, institutions, universities, citizens, etc.) have the opportunity to debate projects and ideas related to mobility in Constanța and its metropolitan area. The main goal of the forum is to generate input from several stakeholders that can then be used by decisional bodies when planning for sustainable mobility (Crăciun, 2020).

The municipality has also taken the path of the smart city approach by testing a series of pilot projects throughout the city, as well as by preparing a Smart City Strategy that is currently undergoing a public consultation process. The strategy targets several aspects of city development including mobility and focuses on how smart city projects can help shape a more sustainable future (CIVITTA, 2020). Together with the strategy, the digitalisation of the governance processes of the city is targeted to ensure efficiency and better communication between citizens and authorities, as well as a higher involvement from citizens. This is highly relevant as the current participation is low (CIVITTA, 2020; Crăciun, 2020; Stadler, 2020).

Summarizing, the existing mobility system of Constanța is highly focused on the car, with the more active means of transportation such as public transport, biking or walking being neglected. Nevertheless, the actions taken in the past few years showcase an interest from the municipality's side towards becoming smarter and more sustainable and having a more integrated approach to mobility. The planned projects, however, are punctual and do not cover the entire range of necessities to overcome the existing problems. Furthermore, some of the projects are still in the planning phase and have an uncertain future as it is not clear whether funding will be provided for such projects.

4. Theoretical framework

4.1. Scenarios

As briefly mentioned in the introduction, worldwide developments, trends and pressing issues call for new scenarios for future planning. On a general note, the term scenario portrays "a postulated sequence or development of events" (Oxford, n.d.), outlining possible outcomes for a certain situation, which can either be real or imagined. Despite being used initially as a method for military missions, it has become more and more popular in the field of public policy and decision-making processes (Stojanović, et al., 2014). Thus, scenarios are often used when dealing with complex socio-technical systems, among which urban planning can be identified (Wiek, et al., 2006) and are one of the methods used in future research (Shiftan, et al., 2003; Stojanović, et al., 2014). By nature, they are a qualitative method that does not necessarily rely on quantitative accuracy (Stojanović, et al., 2014). However, a mix of quantitative and qualitative approaches must be used to build relevant scenarios to ensure good integration of data (Wiek, et al., 2006).

In the context of urban planning, a scenario shows various possible alternatives for the future of cities and urban settlements, based on past and present trends, in order to inform and guide decision-making processes. They have a broad, encompassing nature, allowing for several types of expertise

[5] Buses with the Euro VI standard and low floors that aid the use for people with reduced mobility.

to be integrated (Johnson, et al., 2012). Building scenarios can be left entirely to the experts or it can include the expertise of various relevant stakeholders (Shiftan, et al., 2003). This allows scenarios to be used as different types of instruments in the decision-making processes. On the one hand, they can serve as a planning instrument for modelling the outcome of various types of interventions considered relevant by a group of experts based on the issues identified in the study area (Stojanović, et al., 2014). Alternatively, scenarios can be used as an instrument for discussions and idea generation, providing an environment for participatory planning where citizens, businesses, experts and city authorities can share knowledge (Rupprecht Consult, 2019; Johnson, et al., 2012). More than often, there needs to be a mix between the two approaches, with both bottom-up and top-down perspectives being relevant in the context of building scenarios. Such an approach is known as a design-oriented scenario and aims to concretely identify solutions to achieve a set goal by cooperation among stakeholders (Mancini, et al., 2009).

Applying the logic of building scenarios to the topic of this article, it then implies the outline of possible futures for the mobility system of a given area, having as a goal the targets of smart sustainable mobility. For the scope of the present research, scenario building is taking a planning standpoint, with the scenarios being realised by the author based on the identified problems and the pressing needs, having smart sustainable mobility as an ultimate goal. In this context, scenario building is considered as a base planning method within which forecasts, experts' and citizens' opinions and theoretical considerations are combined to provide an overview of how mobility futures could look like for a set timeline. In this regard, it is first necessary to understand what smart sustainable mobility entails. At a glance, the term is comprised of the concepts of sustainable mobility and smart mobility and the connections between them, all of these being further detailed in the following sub-sections.

4.2. Sustainable mobility

Sustainable mobility can be understood in the context of sustainable development. The latter was firstly defined by the World Commission on Environment and Development within the 1987 Brundtland Report as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (World Commision on Environment and Development, 1987). Since then, further proceedings have been made to shape the concept and in 2015, the 2030 Agenda for Sustainable Development containing the Sustainable Development Goals was adopted by all the UN Member States. The 17 SDGs (see Figure A1) target various subjects that are of high interest in achieving a sustainable future, from hunger, poverty and education to economic growth, cities and climate change (UN, n.d.). Urban development is consistently addressed within the Sustainable Development Goals, with SDG 11 – Sustainable cities and communities, accounting for how cities and urban settlements need to adapt in order to attain sustainable development. Cities are considered one of the key factors pertaining to the discourse, as they provide 80% of the world's GDP. Nevertheless, they also represent a major threat to sustainability through the high levels of energy consumption and carbon emissions, namely around 70% of the global total for each of the two indicators. Urban development is also linked with issues such as urban sprawl, low quality of life, exclusion and social disparities. In this sense, SDG 11 is directly linked with other SDGs (Figure A2) helping achieve external targets such as, but not limited to, good health, clean energy or responsible consumption (UN, 2018).

Moving towards the focus of this paper (i.e. mobility) it is important to understand what is comprehended through this term and how it fits within the sustainability discourse. According to the Oxford Dictionary, mobility can be defined as *"the ability to move or be moved freely and easily"* (Oxford, n.d.). The words "freely" and "easily" define the nature of mobility, thus making it possible to link it to accessibility, inclusion and equality. Very often, the terms mobility and transport are used synonymously to discuss movement in the cities. Although transport is an important component of mobility, the latter is often understood as going beyond the traditional physical exemplification of

travel and is rather portrayed as more than travelling from A to B, including all the practices, experiences and social implications of the act of moving (Jensen, 2013). The article will proceed by using the term "mobility", without disregarding the role that transportation plays within the paradigm.

The need for mobility to become sustainable arises from current trends and patterns, where the car is one of the most used modes of transport. For an extended period, city development was oriented towards the car, allowing people to travel faster and further while giving them a sense of freedom (Jones, 2014; Nieuwenhuijsen & Khreis, 2016). Nevertheless, this has also led to a severe negative impact on cities and the health and wellbeing of citizens. With a steep increase in the stock of vehicles worldwide, as well as high pressure being put on the existing infrastructure, problems such as congestion and pollution have inevitably appeared. Furthermore, the current trends have a negative impact on safety, especially for more vulnerable traffic participants such as pedestrians or cyclists, with the car using up a significant amount of space, more than often consuming public space resources (Makarova, et al., 2017).

Sustainable mobility has no clear assigned definition, but it can be understood as the association of sustainable development implications with the mobility sector. This has been portrayed by several professionals and academics, aiming to provide an approach for achieving sustainable mobility in cities. A popular advocate of such mobility has been David Banister (2007, 2013, 2020) who promoted the idea of sustainable mobility as essential both for citizens and for city development. He argues for careful land-use planning focused on mixed-use development, as well as for good public transportation corridors and nodes that serve the entire city to lower the length of trips, encouraging citizens to walk or bike for short to medium distance trips and using public transport for longer distance trips (e.g. to work). These are essential elements for shifting the mobility system towards a sustainable one and reducing the use of the car (Banister, 2007).

Subsequently, several other additions have been made to the sustainable mobility paradigm by academics, including David Banister himself (2012, 2013, 2020). Sustainable mobility is often displayed as affordable, equal and efficient travel for all citizens in a manner that is considerate of the environment and the others (Lyons, 2018; Bardal, et al., 2020; Holden, et al., 2020). Such considerations have also been sustained through more global approaches promoted by the European Commission and organizations such as the United Nations or the World Bank. In this sense, the concept is being addressed directly within the SDGs, namely SDG 3 – Good health and wellbeing through:

> "Target 3.6. By 2020, halve the number of global deaths and injuries from road traffic accidents" (UN, n.d.)

and

> "SDG 11 – Sustainable cities and communities through Target 11.2. By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons" (UN, n.d.).

These two targets draw attention towards sustainable mobility characteristics, namely safety, equality, inclusiveness and affordability. These are augmented by efficiency and environmental considerations that need to be given to mobility development to ensure little to no negative impact on the environment (World Bank, n.d.). As of December 2019, European countries have been presented with the European Green Deal aimed at helping achieve sustainable development by reducing emissions in several sectors. Sustainable mobility, as one of the targeted sectors, has the specific goal to reduce greenhouse gas (GHG) emissions from transportation by 90% until 2050. This is due to the fact that most of the current greenhouse gas emissions are concentrated in road traffic, accounting in 2017 for 71,7% of the total transport GHG emissions at the European level (European Commission, 2019).

Summing up, sustainable mobility falls under the sustainability paradigm, accounting for the shift in mobility patterns from car-based to environmentally friendly modes of transport. This is highly relevant as mobility constitutes an important sector of city development and it has a direct impact on land use, economy and social behaviours. In this context, it is important to align the goals of mobility to those of lowering the environmental impact, ensuring that general targets, such as those portrayed by the SDGs, are attained and the already existing issues are being ameliorated.

4.3. Smart mobility

As previously mentioned, cities were shaped by several concepts and approaches throughout time. One such approach has emerged in the past 20 years and is illustrated under the Smart City paradigm. The concept has not been clearly defined and has been used differently by several authors portraying it through their definition that more than often serves the purpose of the study within which is portrayed. Nevertheless, the main discussions around the concept relate to the use of Information and Communication Technologies (ICTs) as a means to power the development of cities, as well as to use innovative technologies to overcome some of the issues that cities face (Albino, et al., 2015).

For this paper, the definition put together by the European Commission will be considered. Thus, a city is considered to be smart when ICT technologies are being used to enhance the infrastructure and the services it provides in order to benefit its citizens. Moreover, "a smart city goes beyond the use of information and communication technologies (ICT) […] It means smart urban transport networks, […] It also means a more interactive and responsive city administration, safer public spaces and meeting the needs of an ageing population" (European Commission, n.d.). The reasoning behind using such a definition lies within its broad approach, taking into consideration the technological aspects of the smart cities, but not denying that it also takes into account socio-economical and urban factors. In this manner, the smart city becomes a useful tool or instrument for city development, rather than a goal in itself.

Smart cities are based on six main pillars, namely mobility, environment, governance, economy, people and living (Giffinger, et al., 2007; Cohen, 2018). Even though there is a clear separation between the pillars, the connections between them cannot be denied, as most of them influence and are influenced by the others. In this context, smart mobility can be defined as the pillar focusing on using technology and data collection to better understand mobility trends and patterns in the city to plan accordingly for its development, as well as to make the mobility system more efficient and easier to use (Lyons, 2018). Nevertheless, the use of smart mobility must be aligned with the concept of sustainable mobility (Lyons, 2018) and the connection between the two, encompassed under the umbrella term of smart sustainable mobility will be outlined in the next sub-section.

4.4. Smart sustainable mobility

As already mentioned, relevant to the present subject is to understand the link between smart and sustainable and how they influence each other. This link between the concept of sustainable development and the smart city has been previously portrayed by academics, acknowledging the use of technology as a solution for attaining sustainability (Lyons, 2018; Bardal, et al., 2020) as well as arguing for sustainability as an essential component of smart city development (Silva, et al., 2018; Mohanty, et al., 2016). The smart city in itself does not constitute a goal, but rather it represents an instrument in the process of achieving sustainability, by approaching technology to improve socio-economic and environmental factors in the cities, as a means to minimise or reduce the impact of pressing issues such as urbanization, poverty or climate change (Silva, et al., 2018).

Focusing on the scope of the paper (i.e. mobility), the two concepts of sustainable mobility and smart mobility will not be considered as two different paradigms but will be embraced under an

encompassing umbrella term – smart sustainable mobility. This is also highly relevant in order to limit the possibility of smart mobility overshadowing sustainability goals and threatening its targets (Lyons, 2018). Socio-technical aspects are as important as technological ones when planning for mobility, with the latter being a means to an end. It is necessary that professionals, authorities and academics do not fall under the attractivity of the smart as a new catchphrase (Hollands, 2008), but that they rather foster its applicability in a way that benefits the society.

Assimilating the characteristics of both smart and sustainable, smart sustainable mobility can, thus, be defined as mobility that uses technological advances and incorporates smart city approaches in its development to ensure that the targets of sustainability are achieved. Thus, significant attention is paid to including and promoting active means of transportation such as public transport, walking and cycling, while at the same time ensuring a good integration of all existing means of transport at the city level. It focuses on providing technologically-assisted, high-quality services for its citizens that are safe, affordable, efficient and attractive (Lyons, 2018), as well as on improving the quality of life and participatory processes to ensure that all interested stakeholders' needs are taken into account. On a more practical level, smart sustainable mobility can be exemplified through a series of cases that have proved themselves to be successful. The worldwide portfolio of such projects is wide and for the scope of this paper, it was narrowed down to solutions that are tangible and can be replicated. Furthermore, they consider cities of a similar character either in size, population or localization to that of the chosen case study of Constanța. As the scope of the paper relies on identifying general measures and directions of action, the best practices will not focus extensively on technical or design-related aspects.

The base for any mobility system is the hard infrastructure (i.e. roads, parking, signage, etc.). In the case of smart sustainable mobility, the discussion focuses on both traditional and technological infrastructure that accommodates and promotes the use of active transportation. This amounts to anything from dedicated lanes, parking and charging points to sensors and monitoring devices to ensure the functioning of the system (Mohanty, et al., 2016). One concrete example of such projects is displayed by the Italian city of Pesaro. The city managed to expand its cycling lane infrastructure from 20 km in 2005 to 90 km in 2019 (Comune di Pesaro, 2019). This was possible by implementing the Bicipolitana project which focused on creating an extended, well-connected network that comprises the important nodes of the cities, designed in a way that would follow the logic of metro lines (see Figure 2), with each bicycle route distinguished by a specific number and colour (Barbadoro, 2018). The project integrates bicycle lanes on all the needed streets, ensuring that there is a clear separation between them and the car lanes. The project is currently ongoing, with several more lines being planned for implementation (Comune di Pesaro, n.d.), the target of the city being to reach a cycling network of 180 km (Comune di Pesaro, 2019).

The relevance of the case of Pesaro lies within its approach to construct a bicycle network resembling that of underground public transport, thus giving it a similar status. The project focuses on the main aspects of smart sustainable mobility by promoting safe, affordable and attractive travel by cycling. Furthermore, it is integrated with other measures aimed at reducing the use of cars, such as providing bike-sharing services and the implementation of the limited traffic zones, ensuring the feasibility of the project. The use of technology, in this case, lies within bike-sharing, which is entirely activated through a mobile application and uses innovative design for the bicycles to ensure safety and traceability. Ultimately, the relevance consists of its success illustrated through a high share of trips conducted by cycling (approximately 28%), as well as through the augmented number of cyclists in the city that doubled in just two years (Interreg Europe, n.d.).

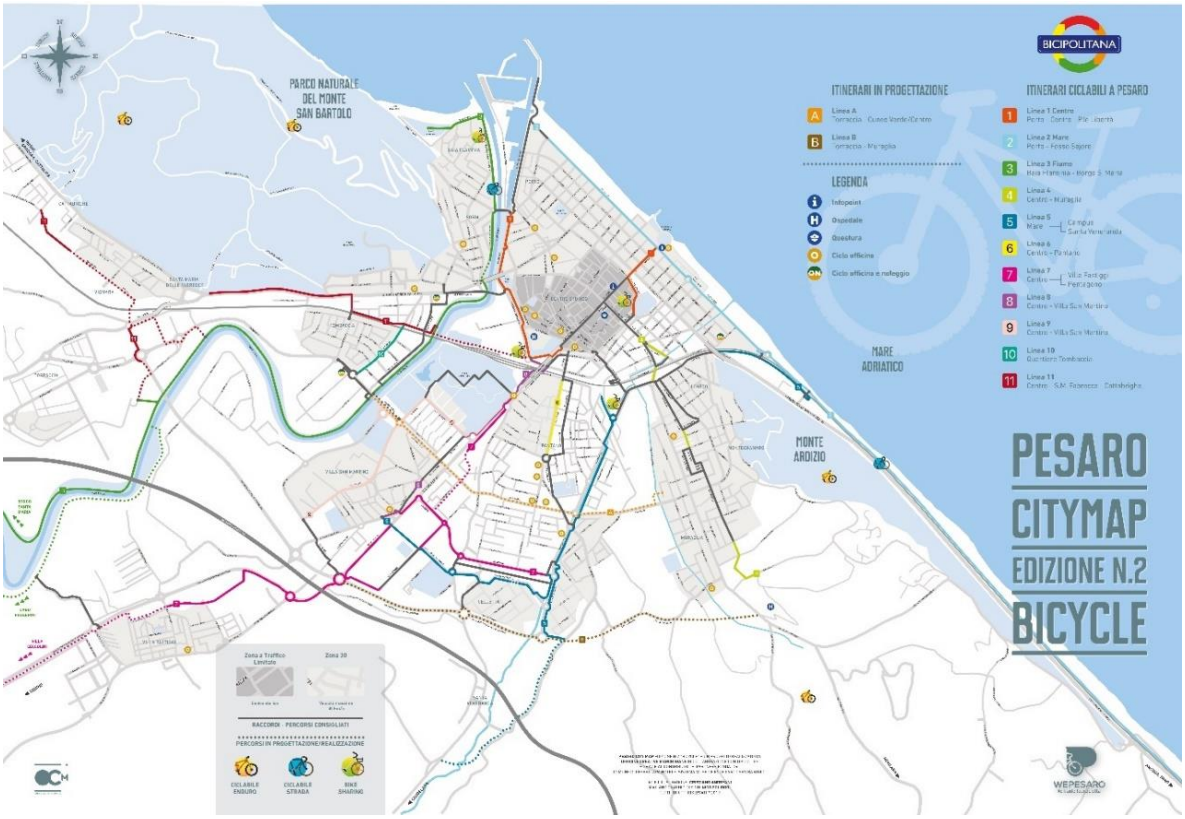

Figure 2. Bicycle map – the city of Pesaro, Italy (Comune di Pesaro, n.d.)

Another popular approach to achieving smart sustainable mobility lies within the concept of Mobility as a Service (MaaS), which refers to the use of technologies that help integrate multiple transportation modes accessible in one single platform to ensure more efficient and seamless travel for citizens. MaaS usually uses a mobile application to make the services available to the public, allowing citizens to choose, plan and pay for their service within the app. The main scope of this approach is to give citizens access to high-quality mobility services that could replace the use of private cars. In this sense, MaaS can incorporate any type of mobility service, with notable and popular examples being public transport, car-sharing and bike-sharing services (Expósito-Izquierdo, et al., 2017). There are several cases worldwide, with cities embracing MaaS as part of their mobility system. From general mobile apps such as CityMapper that works in several cities (e.g. New York, Singapore, Manchester, Amsterdam, etc.) to more targeted approaches such as the OV Chipkaart in the Netherlands and the Oyster Card in London that allow users to pay with the same card for various mobility services, they have all proved to be successful in easing the use of transportation modes in the cities. More recently, such projects have been developed in a way to promote sustainability and work on a reward system-base to encourage citizens to use alternative means of transport over the car.

One notable example is that of the Spanish application Ciclogreen. The app has been used in several cities and helped saved over 2000 tonnes of CO2 since its implementation in 2016 until now (Ciclogreen, 2020). The app is designed for companies and cities to help encourage the citizens to choose more active means of transport, by rewarding them with coins for each km travelled by walking or biking that can be used for various discounts at local partners such as subscriptions, restaurants, bars, cafes and shops (Ciclogreen, 2020). Ciclogreen has started in the city of Seville, Spain, but has since been used in several other cities and by a large number of companies (European Commission, 2018; Limon, 2018).

Kappo and Bike Citizens provide similar features as Ciclogreen and such are highly relevant for smart sustainable mobility in cities as they not only create incentives for using non-motorised means of transport but also provide relevant features for city administrations (see Figure A3). In this sense,

the collected data is provided by the developers to the relevant authorities to have a base for future planning in the city following the citizens' needs (FIWARE, 2018; KAPPO, 2020; Bike Citizens, 2019).

When approaching ways in which smart sustainable mobility could be achieved, it is essential to target the idealisation that has been created around the car. To do so, several European cities have managed to proceed to shift to more sustainable means of transport more rapidly and more successfully than others (Nieuwenhuijsen & Khreis, 2016). In attempts to overcome the dominance of the car, the shift towards alternative means of transport has proved to be successful when accompanied by the right promoting actions to make people aware of their benefits. One such successful case is the "No ridiculous car trips" event campaign conducted by the city of Malmö in 2007. To ensure that it reaches more social categories, the campaign included various initiatives to deliver information such as advertisements, flyers or bicycle maps. Alongside these, a series of events made the campaign livelier and more likely to stand out, such as placing people on their bikes in front of large advertisement banners, contests, giveaways and concerts (see Figure 3). The campaign was deemed successful as it resulted in 9% of the citizens using their cars less frequently, as well as 16% of them considering to change their travel habits (Eltis, 2015).

Figure 3. The "No ridiculous car journeys" campaign – Malmö, Sweden (The Urban Observer, 2013)

Summarizing, smart sustainable mobility combines the need for sustainable development with the more modern approach of the smart city to portray how urban mobility systems could lower their current negative impacts on both the social, economic and environmental dimensions of society. The use of technology becomes a highly useful tool for developing mobility solutions that provide safe, affordable, efficient and attractive services for citizens. Furthermore, an integrated approach to planning and public participation are key components of developing mobility in a smart and sustainable way.

5. Analysis

As previously mentioned, scenarios are an instrument to outline possible futures for cities and their various components. Drawing on from the theoretical framework previously outlined in

relation to smart sustainable mobility and the case of Constanța, the article moved forward to analyse three main scenarios, namely:

- *Business as usual*, presenting the outcome of continuing the current situation, taking into account the planned projects and an estimated impact they might have upon the mobility system;
- *Shifting home-work-home commuting*, presenting the effects of targeting commuting for work purposes by incentivising the use of more active means of transportation in the city;
- *Promoting non-motorised transport*, showcasing the impact of implementing a coherent infrastructure network, supported by raising awareness, education and knowledge transfer.

The three scenarios follow the timeline 2020-2030 in the target year set by the SDGs. Nevertheless, their short-, medium- and long-term implications were considered. Moreover, despite the fact that the scenarios are targeting a specific mobility situation, they do not deny the importance of the entire mobility system. Thus, the significance of each scenario in relation to the entire system was subsequently presented. To provide a general demographic and spatial overview for the city in 2030, a set of base indicators was used to ensure relevance and compatibility between the scenarios. These indicators are relevant for analysing the mobility system, as it resulted from the theoretical framework, and they are portrayed in Table 1 below.

Table 1. Indicators for building scenarios

Indicator	Short description
Population	The number of inhabitants in the city
Population density	The number of inhabitants per km^2
City area	The surface area of the city expressed in km^2

As the indicators are equally valid for all the scenarios, they will be presented beforehand. Therefore, from a demographical point of view, the city has faced an average annual decline of 0.43% in the past 20 years. Considering a similar pattern, it can be extrapolated that the city will have a total population of 298,241 in 2030. In terms of density, the current situation accounts for 2,493 inhabitants/km2. Nowadays, no further expansions of the city are projected, however, if not monitored accordingly, uncontrolled urban expansions could appear in the near future in Constanța. This phenomenon together with a decline in the population could lead to a decrease in population density. However, as no specific data is available, it is difficult to accurately predict what the decline in population density will be by 2030.

5.1. Scenario 1 – Business as usual

The first scenario depicts the situation as it will naturally evolve based on exiting trends and taking into account the already planned projects that are expected to be completed in the immediate future. In such circumstances, the city of Constanța will continue to evolve as a car-oriented city. Based on the growth trends identified between 2011-2017, as well as on the predictions made in the Sustainable Urban Mobility Plan, the motorisation rate will have a yearly average increase of 2.5%. However, the result in 2030 differs depending on the source (see Figure 4). Based on statistical predictions using the official data (i.e. the stock of vehicles and the population for the respective years), the trend illustrates an outcome of roughly 500 vehicles/1000 inhabitants. On the other hand, the SUMP anticipates only 410 vehicles/1000 inhabitants. Taking into consideration that the SUMP forecasts are based on data retrieved from a survey on a limited number of the population (i.e. 4450 citizens) and subsequently extrapolated to the entire population (WSP/Parsons Brinckerhoff, 2015), they are considered to have an error margin and, thus, possess a level of inaccuracy. Nevertheless,

both the outcomes display a steep increase in the number of vehicles, resulting in higher usage of the car as a mode of transport.

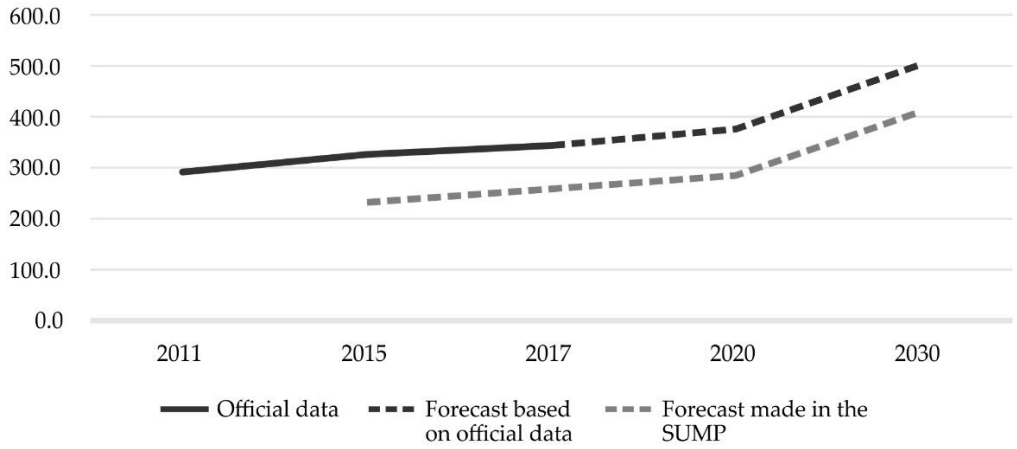

Figure 4. Motorisation rate in the city of Constanța in the period 2015-2030; source: own processing based on statistical data retrieved from the Parking Policy of Constanța (Constanța Municipality, 2018), SUMP of Constanța (WSP/Parsons Brinckerhoff, 2015)

This situation is further illustrated through the modal share. In the period 2015-2030, the share of trips made by car will increase by 8%, while the walking and public transportation will be used less, with a decrease in the share of 4.3% and 4.6%, respectively[6]. In this context, cycling is not taken into consideration and no data is made available. The results of the questionnaire show that top destinations where people travel daily are the workplace (73.4%), the shopping areas (57.6%) and the tourist areas of the city (33.8%). This is highly unlikely to shift completely in the next ten years, as working, shopping and leisure are main activities in the day to day life of an adult.

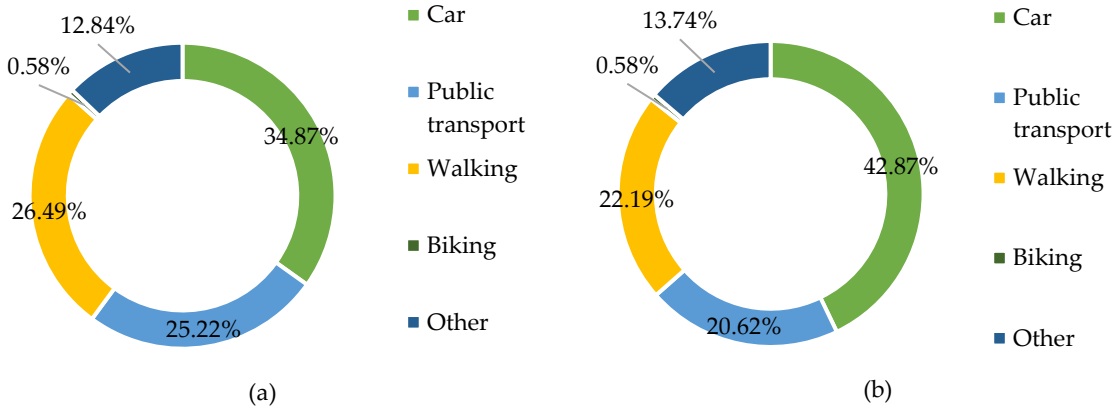

Figure 5. The shift in the modal share of Constanța in the period 2015-2030: (a) Modal share of Constanța in 2015 (WSP/Parsons Brinckerhoff, 2015); (b) Modal share in Constanța in 2030.

By 2030, the projects currently found on the municipality's agenda will be implemented, bringing improvements to road and public transport infrastructure and expanding the cycling and pedestrian one. These include maintenance, road reorganisation, implementing dedicated bus lanes,

[6] The calculation was made based on the data from SUMP's transport model, being the only data that could be retrieved at the moment of writing the article.

extending bicycle lanes and pedestrianizing parts of the city centre. The interventions are illustrated in Figure 6.

Figure 6. Mobility interventions in Constanța by 2030: (a) road, pedestrian and cycling infrastructure; (b) public transport infrastructure; own map creation, with base map retrieved from Google Maps.

As can be seen, the interventions are fragmented, sectorial and predominantly concentrated in the city centre, with little connection towards the outer areas, where it is expected for current mobility issues to persist. Furthermore, despite considerate efforts from the municipality's side to implement measures that would limit the use of the car, at least in the central area, the citizens show a clear pattern of reluctance towards such interventions, which has been portrayed through their contestation of these measures (Crăciun, 2020). Furthermore, the results of the questionnaire showcased that 35.3% of the citizens do not use more active means of transportation due to the attractiveness of using their car, with 5.8% of the respondents never walking or cycling in their day to day activities. Taking this into consideration, it can be predicted that without any clear measures to raise awareness towards more active transportation and to support behavioural change, any further interventions into realizing the shift away from cars are less likely to be implemented and/or accepted.

To conclude, the Business as usual scenario illustrates the tendency of Constanța to develop in an unsustainable way. From this perspective, in 2030, the city will face excessive pressure on the road infrastructure, problems of congestion, insufficient parking spaces, increased number of road accidents, reduced resources of public space and environmental issues generated by the extensive use of the car, such as increased emissions and noise pollution. The level of digitalization will be low compared to European standards, with no attention given to the electrification of vehicles or to using integrated mobility services such as MaaS. Such a condition goes against the framework presented in Section 4 that sets the approach for the analysis, resulting in a mobility system that falls out of the scope of smart sustainable mobility.

5.2. Scenario 2 – Shifting the home-work-home commute

The second scenario builds on smart sustainable mobility initiatives for shifting home-work-home commuting to more active means of transportation. The scenario takes into consideration that the infrastructure projects presented in Scenario 1 will be implemented and will contribute to the

mobility system. In this regard, consideration is given to actions that enhance the mobility system by providing incentives for employed citizens to use more sustainable transportation means over the car.

The acquired data demonstrates that a high share of commuting in Constanța is realised between the home and the workplace of an individual. This has been proved both in the Sustainable Urban Mobility Plan, as well as through the conducted questionnaire. While the SUMP shows the highest share of trips (nearly 35%) being made between home and work, the questionnaire revealed that 73.4% of the respondents chose the workplace as one of their main commuting destinations. There is no clear, correlated data for the main means of transport used for each type of commuting. However, the questionnaire revealed, that 63% of the respondents who commute for work purposes use the car, with public transport and non-motorised transport being less popular (see Figure 7).

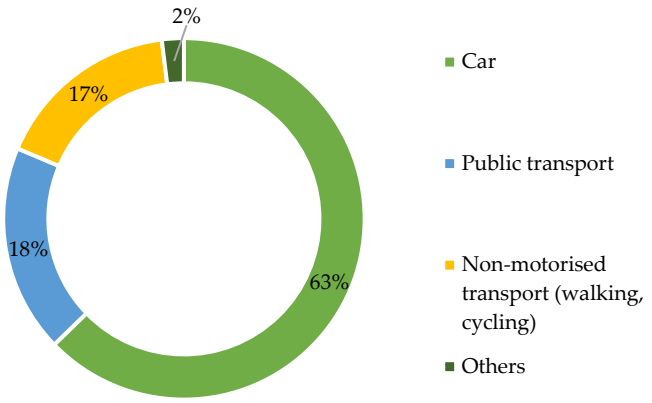

Figure 7. Modes of transport used for daily activities in Constanța, based on the results of the questionnaire

Under these circumstances, by 2030, the city will take advantage of Mobility as a Service and draw in local companies and businesses to join the authorities in promoting smart sustainable mobility. Economic entities will play a crucial role in supporting such means of transport by encouraging their employees to use them through various incentives. The city will have its mobility application, where both employed and non-employed citizens can sign in to use the mobility services available at the city level, including public transport, bike-sharing and car-sharing, as well as additional services such as taxis, ride-hailing or electric scooters. A rewarding system will be set in place both by the municipality and by employers, using gamification methods to reward sustainable transportation patterns. For employees, rewards could range from free public transport subscriptions to extra vacation days or monetary rewards for taking the bus or the bike to work, whereas generally valid benefits include discounts and offers at local businesses. To encourage companies to join the movement and help support sustainable transport, the municipality will set in place policy measures such as the reduction of taxes, packet deals for multiple public transport and bike-sharing subscriptions for employees or expert help on promoting sustainable transport.

The initiative will not only help incline the balance in favour of active transportation, but it will also be a suitable method for collecting relevant data about commuting patterns. In this sense, in 2030, Constanța will have a concrete starting point for urban mobility planning, based on factual data that portray trends, patterns and gaps in the system. The data will be collected in an integrated database, with a spatial dimension for easy illustration and dissemination of data (such as GIS), that will be made available for involved companies, different municipal entities, as well as for the public to consult. This will lead to higher transparency from the municipality's side, as well as to a more efficient administration.

The feasibility of such an approach lies within the acceptance of the citizens towards using digital mobility services. 57% of the respondents of the questionnaire are open to using a mobile application dedicated to mobility services, with 27% of them wanting an integrated app for multiple modes of transport and 7% aiming for a reward-based application. Moreover, 31% of the respondents were curious to try such an application. Only 4% of the respondents would never use it, with the rest of 8% not knowing or preferring not to answer. Furthermore, 66% of the respondents are already using the available apps for mobility.

As a result of this initiative, it is expected that the modal share will change, with more attention being given to public transport and cycling specifically, as portrayed in Figure 8.

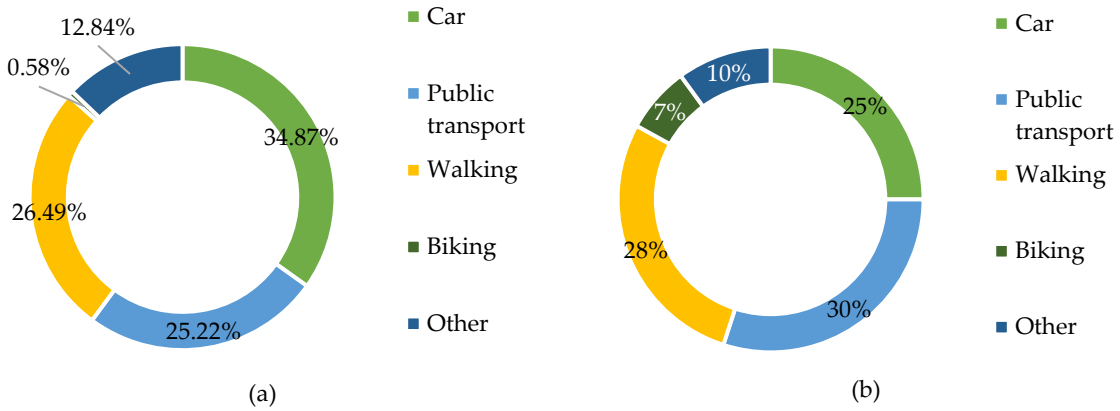

Figure 8. The shift in the modal share of Constanța in the period 2015-2030: (a) Modal share of Constanța in 2015 (WSP/Parsons Brinckerhoff, 2015); (b) Modal share in Constanța in 2030.

To summarize, the second scenario portrays a future in which commuting for work purposes is oriented towards active means of transportation, thus relieving the pressure off existing infrastructure, especially during rush hours. The system is based on extensive cooperation between the private and the public sector, with technologically assisted interventions aiding data generation and collection that is further used to adapt and adjust the mobility system accordingly. In this way, Constanța's mobility system becomes smarter and more sustainable and is based on more integrated approaches.

5.3. Scenario 3 – Promoting non-motorised transport

The third scenario exemplifies a future in which non-motorised transport has a considerable contribution to the mobility system. As the questionnaire results have shown, in the present, only 4% of the respondents are biking and 13% walking for their daily activities, with approximately 28% of them using non-motorised means of transport once a week or less. The main reasoning behind the low choice of non-motorised transport lies within the lack of time, habit and unfavourable weather conditions. Safety and lack of appropriate infrastructure are also reasons mentioned by the respondents. These are issues that need to be addressed if smart sustainable mobility is to be achieved. The scenario takes into account that the projects exemplified in Scenario 1 will be fully implemented by 2030.

In this regard, in 2030, Constanța will have an integrated mobility system oriented towards active transportation. It provides the right infrastructure for biking, walking and public transport and encourages its citizens to actively participate in the development of mobility initiatives. This is supported by complementary measures such as a comprehensive parking policy, pedestrianization

of the city centre, park&ride facilities and intermodal nodes at the city level. An overview of Constanța non-motorised network in 2030 can be seen in Figure 9, below.

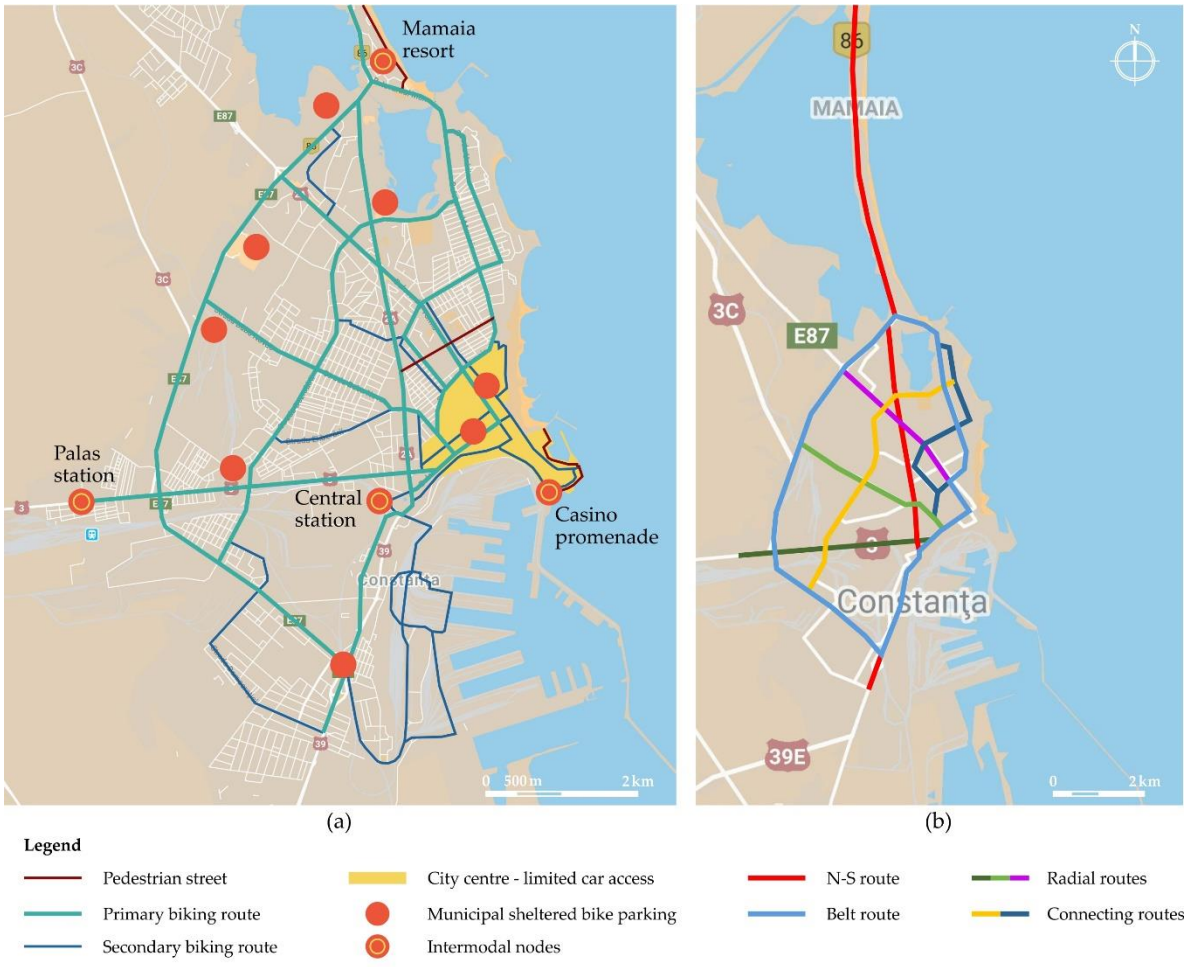

Figure 9. Non-motorised mobility system in Constanța – 2030: (a) implemented infrastructure; (b) cycling network; own map creation, with base map retrieved from Google Maps.

As indicated, the non-motorised network will be comprised of primary and secondary routes, connecting the most important facilities at the city level. Additional infrastructure such as bike parking or repair points will be provided in key nodes, as well as throughout residential and port areas. The network will be sustained by technology in the form of sensors, information panels, smart infrastructure and data collection mechanisms that will strengthen the integrative character of the mobility system, thus tying into the smart sustainable paradigm. All these efforts are accompanied by constant and coherent promotion campaigns that target several social groups to raise awareness towards non-motorised transport, as well as to educate the population regarding sustainability. Various stakeholders are invited to participate and share knowledge to ensure that any further projects are reliable and in line with the city's goals. Such an approach will transform the modal share, with 75% of the trips being made through active transportation (Figure 10). As a result of lowered car use, there will be a significant reduction in pollution and increased health benefits for citizens. Furthermore, as citizens will shift towards more active transportation, the existing infrastructure will be able to support the high number of tourists coming by car to Constanța during the summer season, without the need for supplementary interventions.

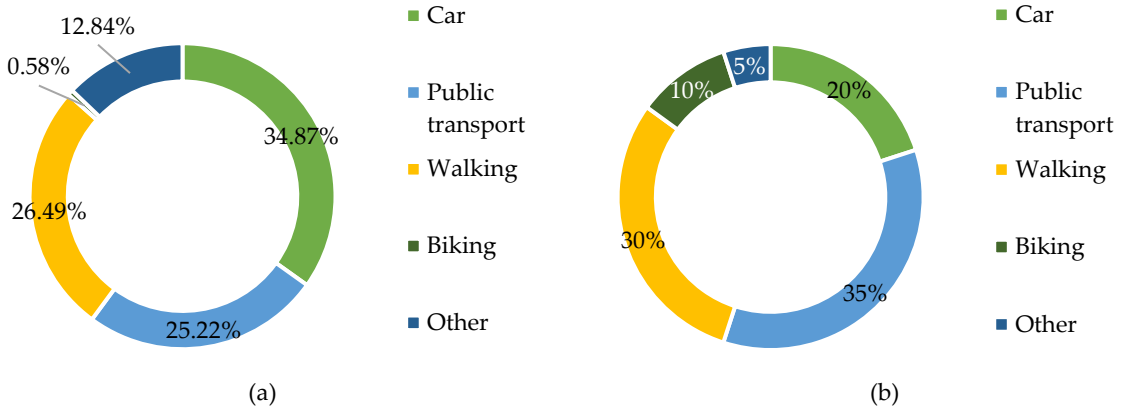

Figure 10. The shift in the modal share of Constanța in the period 2015-2030: (a) Modal share of Constanța in 2015 (WSP/Parsons Brinckerhoff, 2015); (b) Modal share in Constanța in 2030.

To summarize, this last scenario outlines the benefits of non-motorised transport in the context of Constanța, showcasing how more radical interventions can contour a significant change in the mobility system. The mix between the right infrastructure, technology, and raising awareness provides the right setting for attaining smart sustainable mobility, while at the same time adapting to the local context.

6. Discussion

The article started by setting the scene for smart sustainable mobility and the need for such a shift to happen in order to counteract some of the issues identified both globally and in the selected case study, such as congestion, intense car use, pollution and poor civic participation. The research focused on identifying possible solutions for the city of Constanța in the form of scenario building as an instrument for future planning based on existing trends and expected and/or proposed interventions. The scenarios take an individualistic approach, being constructed by the researcher based on factual data and necessities of Constanța, using a mix of qualitative and quantitative methods. The scope of the present section is to answer the third sub-question and to evaluate the impact each of them could have in Constanța. Even though there will be a set of comparisons between the three scenarios presented above, the choosing of a relevant scenario goes beyond the scope of the article. This is partly due to time and resource limitations, as well as to the lack of accurate mobility data, which made it difficult to contour a set of indicators comparable in a way that would lead to choosing one scenario over the other.

In the circumstances presented in the first scenario, it is clear that Constanța will remain a car city, with accentuated problems of road infrastructure, pollution and taking over public and green space due to the high demand for parking space. Even with the planned interventions that the municipality has for the next years, it is unlikely that there will be a shift in the mobility system. This is due to the lack of an integrated approach to planning, with fragmented, individualised interventions that are concentrated in distinct parts of the city without clear connections between them. Furthermore, the low level of public participation and the reluctance towards renouncing the car minimise the chances of significant change. Without clear actions to educate and raise awareness towards active modes of transport, as well as to incentivise them, there is little to no potential for citizens to change their mobility behaviours on their own, thus maintaining an unsustainable mobility system.

The other two scenarios take as a starting point two of the identified issues, where planned projects are minimal and the municipality has no specifically expressed interest in. This is not to say

that there is not a large variety of other approaches. However, in the context of smart sustainable mobility and the specific case study of Constanța, the two should be of high relevance for future mobility planning. They relate to non-motorised transport and are also highly pertinent in the current context of COVID19, when an extensive number of discussions focus on how urban mobility will face a significant change in a post-pandemic context, as a result of the need for social distancing and safer means of travel to avoid contacting and/or spreading the virus. In this sense, walking and cycling will become essential, with cities needing to adapt to new settings rapidly (Connolly, 2020; Huet, 2020).

In this sense, the second scenario focuses on the main type of commuting in the city (i.e. home-work-home commuting) and how it can be shifted from the car to more sustainable means of transport. Technology plays a crucial role in this matter, as it can be a useful tool for incentivizing citizens, as well as for data collection, which is illustrated through the use of a MaaS application that incorporates all available mobility service, while at the same time using a reward system for travel behaviour oriented towards active transportation. What is essential in this scenario is the cooperation between the municipality and other stakeholders for attaining this goal, as it increases the chance of success by providing an extended network of implicated bodies that support the paradigm shift. Furthermore, such an approach creates the basis for non-motorised transport to be embedded in citizens' behaviours and to develop a tradition that could be later extended to other typed of daily travel. If Western European cities have already developed such traditions (e.g. Malmö, Copenhagen, Utrecht, etc.), Romanian cities, with a few exceptions, have yet to develop such habits (Stadler, 2020), which in this context need to be fully encouraged.

The third scenario and also, the most ambitious one, focuses entirely on the use of non-motorised transport as a means of primary travel, as opposed to the present situation where walking and biking are predominantly leisure related. Creating a non-motorised transport network supported by additional measures and policies aimed at smart sustainable mobility can easily counteract the need to extensively use the car, as it has been showcased in multiple case studies around the world. Taking into consideration the context of Constanța, where planning is focused on a safer approach, a radical change needs to be thoughtfully designed, keeping in mind that the timeline for implementing such a project could extend beyond the one set in the scenario. However, by 2030, the city should be able to partially implement the project and to suitably support it through awareness and educational campaigns. At the level of the year 2030, the impact should already be deemed significant, with visible pollution reduction, better health, augmented public and green space, as well as an integrated, well-connected mobility system.

All of the three scenarios focus on the next ten years, looking at how Constanța will look like in 2030. However, it is worth mentioning that generally, scenarios base themselves in current trends and on known hypotheses, which leaves them vulnerable to unexpected situations that might arise along the way. Natural disasters, health hazards (e.g. pandemics), economic crises, legislation changes at both national and European level, the development and new and innovative technologies, lack and/or shortage of resources are all factors that could influence the outcome of a given scenario. In this sense, the suited authorities should be easily adaptable to new situations and importance needs to be given to constantly monitoring and adjusting the scenario based on newly acquired input, without jeopardising the final goal. All of these factors can have a direct impact on the timeline of a scenario, leading to longer implementation times. This is a highly relevant risk for the city of Constanța, where a slow process of solving the problems in the city can be found (Crăciun, 2020).

The presented scenarios are an outline of how planning could be conducted in Constanța to achieve the best outcome. They should be visualised as instruments for discussion and co-creation of mobility futures in the city and should be based on multiple types of expertise to ensure a higher accuracy (Johnson, et al., 2012). They also allow for flexible planning, where decisions are made having in mind a variety of outcomes and the possibility of change, uncertainty and impediments that might come along the way. Scenarios can, thus, aid the resilience of planning processes through a series of monitoring measures to help them adjust along the way. Furthermore, they set the base

for future strategies by bringing together the type of knowledge that cannot be generated only through numerical accuracy, more specifically socio-economical aspects. These additions come from the collaboration between various stakeholders and make us of the mutual effort of outlining a future vision for the city.

Drawing from the built scenarios, as well as from the necessities identified in Constanța, a set of recommendations has been framed in correlation with the smart sustainable mobility concept. As the scope of the paper is to showcase how scenario building enhances future planning for smart sustainable strategies, the recommendations are illustrated in a more general tone and take the form of a series of principles that support the process of future planning for Constanța. The recommendations are addressed to the municipality and city authorities of Constanța and are described below:

- Develop mobility plans in an integrated manner, concentrating on the links between all transportation modes and ensuring that all the important primary and secondary centres in the city are connected.
- Take advantage of the technological innovations in the mobility field that are rapidly advancing and of the added value they bring to mobility interventions. This not only helps to put Constanța on the smart cities map but also aids and simplifies the management and control of all types of traffic, while at the same time helps collect relevant, accurate data for further mobility analysis such as commuting patterns, modal share, citizen engagement, etc. This comes as a response to both the lack of available mobility data, as well as for poor pedestrian and cycling infrastructure.
- Make use of the existing discussion forum implemented within the PORTIS project to encourage and stimulate citizens to participate in decision-making processes to fruitfully plan for future development. What is essential is that various stakeholders get together to share and generate ideas based on various types of expertise that are crucial for city development and, implicitly, for mobility development. In this sense, scenarios are a useful tool for discussion and, as portrayed throughout the article, they can be used in various ways that help illustrate possible futures for a city.
- Expand the expertise of the public administration by attracting mobility experts and professionals to work for the municipality, enlarging the existing knowledge base in order to be able to support more complex analysis and advance the right instruments for mobility planning.
- Educate and raise awareness towards the benefits of active mobility both for the citizens and for the city. An automatic shift towards smart sustainable mobility is unrealistic and hard measures (i.e. infrastructure) need to be supported by soft measures to help achieve the desired goal.
- Be more ambitious when it comes to mobility interventions. As it is portrayed today, the interventions still focus on satisfying the demand for all modes of transport, including the car. This approach should be shifted and more progressive planning should guide Constanța's development, especially in terms of mobility.

Summing up, scenario building provides the right environment for discussing and assessing various possible mobility alternatives for the future, based on contextual data provided by different stakeholders. The cooperation among urban actors means extended expertise and a broader, more accurate overview. In Constanța scenarios could fill in the current gaps that municipal planning faces in this domain and the portrayed recommendations come as supporting principles to ensure that mobility planning becomes effective, integrated and transparent, without losing sight of the overall targets of smart sustainable mobility.

7. Conclusion

The article examines the relevance of scenario building for attaining smart sustainable mobility at the city level. The research aimed to identify how scenarios can set the scene for elaborating future strategies in the cities regarding urban mobility. To do this, the report uses the case study of Constanța, Romania, where pressing mobility issues include lack of integration between modes of transport, degraded and poorly designed infrastructure, as well as limited interest towards non-motorised transport. These, together with high car usage and low public participation negatively impact the functioning of the city, contouring an unsustainable mobility system.

The theoretical framework sets out the understanding of smart sustainable mobility and its importance in relation to cities and urban settlements. Therefore, the concept becomes a goal for future mobility planning, where technologically assisted, environmentally friendly and socially inclusive mobility systems are the standard. Such futures can be exemplified through scenario building, a useful instrument for illustrating various alternatives for a set timeline, taking into consideration comprehensive expertise acquired through a mix of quantitative and qualitative data,

To answer the posed research question *"How can scenarios for smart sustainable mobility enhance new urban strategies for the future of Constanța?"*, it is important to mention the nature of scenarios as an iterative process of future planning for Constanța. Firstly, the expert assessment of the current situation and the realization of preliminary possible scenarios are conducted, followed by discussions and consultation with various public and private stakeholders on the drafted scenarios as a means to identify through idea generation and knowledge share the best possible solutions for the city of Constanța. These steps help shape concrete plans and strategies for urban mobility in Constanța based on significant input, as well as on concrete issues and needs. Additionally, the involvement of different stakeholders enhances the acceptability and understanding of the plans and strategies, impacting directly their efficiency. The chosen scenarios and their affiliated interventions need to be monitored throughout their implementation to guarantee that, in case of unpredicted events, additional measures are taken to ensure their successful outcome.

Furthermore, they represent a means to extend the municipality's expertise and to acknowledge different views that will benefit the planning process. The presented scenarios are relevant in the context of smart sustainable mobility and outline how planning for such a goal could be conducted in the case of Constanța. This is relevant as current mobility planning is fragmented, oriented towards combining old and new paradigms and relying on little concrete data. The scenarios provide a more standardised, methodologic approach to planning, with alignment among goals and targets, in this case, those of smart and sustainable mobility. Such an approach represents a way in which Constanța can progress and make a purposeful change towards counteracting current mobility problems and meeting smart sustainable mobility standards. Although the research focuses on Constanța, the situation is similar in many other Romanian cities (Crăciun, 2020; Stadler, 2020), with scenario building having the potential to be scaled and replicated as a beneficial method for defining the mobility futures of other cities.

All in all, the use of scenarios is an essential instrument for deciding on future mobility development, both in terms of showcasing the possibilities and analysing their outcomes and in terms of creating a forum for discussion and co-creation among relevant stakeholders. The process of analysis is a coherent, encompassing way of evaluating which alternatives are better for a specific context. Scenario building sets the path for future urban strategies and they can be used not only, in relation to mobility, but can also be expanded to other complex, socially embedded, constituent elements of urban development.

The present research has identified several comprehensive information concerning smart sustainable mobility and scenario building, drawing on interesting discussions in the field of urban planning. Nevertheless, the addressed subject is broad an expands beyond the scope of this article. In this sense, the subject could be researched further with consideration given to more in-depth participation from relevant stakeholders in Constanța. The current situation of COVID19 has led to

the impossibility to assess the scenarios together with citizens, city officials and other interested parties to the extent that would allow the choice of a suitable scenario for Constanța. This could be further developed through focus groups, interviews and workshops in subsequent studies, taking as a starting point the results of current research. Furthermore, the post-pandemic context itself becomes a subject of interest for further research, taking into account how social distancing and health safety will impact the way people move within the city. Lastly, the article is limited to a singular case study, which, however, can be used as a starting point for much larger research into how scenario building for urban mobility can be scaled and defined in other contexts.

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Appendix A

A.1. Research design overview

Table A1. Research design

Problem statement
The existing mobility system of Constanța is highly focused on the car, with the more active means of transportation such as public transport, biking or walking being neglected. Despite noticeable interest from the municipality's side towards becoming smarter and more sustainable, the planned projects, however, are punctual and do not cover the entire range of necessities to overcome the negative impact of the car. This calls for a new approach to addressing urban mobility issues that ensures that the overall goals of smart sustainable mobility are attained.
Research question
"How can scenarios for smart sustainable mobility enhance new urban strategies for the future of Constanța?"
Sub-questions
1. How can scenarios for smart sustainable mobility be defined? 2. How can scenarios for smart sustainable mobility be built for the case of Constanța? 3. How can scenarios be a mean of evaluations for future planning choices related to smart sustainable mobility in the city of Constanța?
Methods
Literature review (academic writings, best practices, municipal documents), questionnaire, interviews, forecasts

A.2. Interview guide 1 – Adrian Crăciun

The interview started with a short presentation between the researcher and the interviewee in which the scope of the research has been presented and the interviewee has presented himself. The list of asked question has been sent to the interviewee prior to conducting the online interview and they are as follows:

1. Which existing strategic documents focus on urban mobility and which are the main directions of action/targets for Constanța in terms of urban mobility?
2. What are the main problems that Constanța faces nowadays in terms of mobility, both at a macro level (county, metropolitan area) and at a local level and which are the areas where such problems are concentrated the most?
3. What are the main mobility projects already implemented in Constanța?
4. What are the main mobility projects that are planned to be implemented in the next 10 years?
5. What efforts/initiatives can be found in relation to the Smart City approach?
6. From your point of view, is transforming the city in a non-motorised mobility oriented one a viable strategy for Constanța?
7. Are there any pilot projects/research projects currently undergoing in the field of urban mobility?
8. Constanța is part of the CIVITAS PORTIS project. Could you provide some more details regarding what the project entails and what is its stage in the present?
9. If you have any additional information or comments to add please address them now.

A.3. Interview guide 2 – Reinhold Stadler

The interview started with a short presentation between the researcher and the interviewee in which the scope of the research has been presented and the interviewee has presented himself. The list of asked question is as follows:

1. How would you characterize the current mobility system of Constanța?
2. What are the main problems that Constanța faces nowadays in terms of mobility and which are the areas where such problems are concentrated the most?
3. What are the main projects that would be essential for improving the current mobility system if we were to consider a short to medium time span (5-10 years)?
4. Are there any pilot projects/research projects currently undergoing in the field of urban mobility?
5. According to the initiatives conducted within the PORTIS project, a discussion forum for urban mobility has been set in place for the stakeholders in Constanța. Are you familiar with the said forum and if so, in your opinion, what is the potential of such a discussion environment?
6. What do you think would stimulate the citizens to participate more in the planning and decision-making processes of the city?
7. In your opinion, is Constanța a city with the potential of becoming a biking city?
8. If you have any additional information or comments to add please address them now.

A.4. Questionnaire outline

Urban mobility: smart sustainable mobility system for the Municipality of Constanța

The present questionnaire is addressed for all the citizens of the Municipality of Constanța and targets the existing mobility system in the city, as well as its digitalisation. The questionnaire is oriented towards non-motorised means of transport, namely walking and cycling. The scope of the questionnaire is to collect citizens' opinions and to identify their main needs in relation to urban mobility.

Filling the questionnaire takes aproximately 10 minutes. It is completely anonymous and purely informative, the answers being collected and processed in order to complete my thesis paper.

Thank you for your participation!
* Required

1. Age: *
Mark only one oval.

- ◯ <18 years
- ◯ 18 - 25
- ◯ 26 - 35
- ◯ 36 - 45
- ◯ 46 - 55
- ◯ 56 - 65
- ◯ >65

2. Gender: *
Mark only one oval.

- ◯ Female
- ◯ Male
- ◯ Other
- ◯ I'd rather not answer

3. In your opinion, how is a sustainable urban mobility system defined? *
Choose maximum 3 options.

- ☐ Promotes non-motorised transport (walking, cycling)
- ☐ Promotes the use of environmentally friendly vehicles (e-cars)
- ☐ Uses a well defined transport system, based on a variety of means of transport
- ☐ Ensures a high level of accesibility for everyone, including the citizens with a low level of mobility
- ☐ Ensures easy transfer between the different means of transport, through intermodal nodes situated at city level
- ☐ Uses digital means to improve the mobility services (mobile apps, informative panels, online platforms, etc.)
- ☐ Other: .....

Urban mobility in the present

4. What are your main travel destinations for daily activities? *
Choose maximum 3 options.

- [ ] Workspace
- [ ] Education facilities
- [ ] Shops/commercial centres
- [ ] City centre (Peninsula)
- [ ] Public institutions
- [ ] Cultural facilities
- [ ] Sports and leisure facilities
- [ ] Green areas
- [ ] Medical practice, clinics, hospitals
- [ ] Touristic areas (the Casino Seafront, the Tomis Port, Mamaia Resort, etc.)
- [ ] Other: .....

5. What is the main transport mode that you use for your daily activities? *
Mark only one oval.

- ◯ Personal car
- ◯ Public transport
- ◯ Walking
- ◯ Bike
- ◯ Scooter/skates
- ◯ Other: .....

6. How often do you use non-motorised means of transport (walking, cycling) to conduct your daily activities? *
Mark only one oval.

- ◯ Daily
- ◯ 2-3 times a week
- ◯ Once a week
- ◯ Less than one time a week
- ◯ Never

7. What are the motives that impede you to use such means of transport more often? *

Choose maximum 3 options.

- ☐ Commodity
- ☐ Habit
- ☐ Bad weather conditions
- ☐ Social status
- ☐ Lack of time
- ☐ Other: .....

8. In your opinion, what are the main issues related to non-motorised transport in the present? *

Choose maximum 3 options.

- ☐ The atractivity of the car
- ☐ Lack of proper infrastructure
- ☐ Insufficient promotion of non-motorised means of transport
- ☐ High costs (e.g. buying/renting a bike)
- ☐ Other: .....

9. What will determine you to use non-motorised means of transport (walking, cycling) more often? *

Choose maximum 3 options.

- ☐ Attractive, safe and well connected sidewalks, pedestrian streets and public spaces
- ☐ An extended network of bicycle paths that ensures easy connections with the main interest nodes
- ☐ Rewarding systems for using non-motorised means of transport instead of the car
- ☐ Bike-sharing systems and easy bike rental centers in the entire city
- ☐ Better informing on mobility posibilities at city level and for the benefits and negative impacts of each mode of transport
- ☐ Mobile apps/online platforms that allow a good route planning based on the users' needs
- ☐ High connectivity between non-motorised transport and public transport (bike parking in public transport station, bring your bike on the bus, etc.)
- ☐ Other: .....

10. If you have any other comments regarding the mobility system in the Municipality of Constanța, please mention them below.

Digitalisation of mobile services

11. Are you using digital services (mobile apps, online platforms, etc.) for urban mobility? *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ I don't know
- ◯ I'd rather not answer

12. If your answer was yes, how often do you use such services?

Mark only one oval.

- ◯ Daily
- ◯ 2-3 times a week
- ◯ Once a week
- ◯ Less than one time a week

13. If your answer was no, what is the main reason for not using digital services?

Mark only one oval.

- ◯ I did not need it
- ◯ I am not familiar with using digital devices (mobile phone, tablet, computer, etc.)
- ◯ For security and confidentiality reasons
- ◯ There are not enough available/trusted options
- ◯ I don't have a specific reason
- ◯ I'd rather not answer
- ◯ Other: .....

14. To what extent would you use a digital service (mobile app, online platform, etc.) built especially for non-motorised transport (walking, cycling)? *

Mark only one oval.

- ◯ I definitely would, I have been searching for a long time for such an app that is available in the city
- ◯ I would use the service only if it's integrated with other means of transport (public transport, car, etc.)
- ◯ I would use the service only if it offers me some rewards
- ◯ I am curious to test such a service, but I am not sure I would use it constantly
- ◯ I don't know
- ◯ I would not use such a service
- ◯ I'd rather not answer
- ◯ Other: .....

15. If you have any other comments regarding the digitalisation of the mobility system, please mention them below.

Appendix B

Figure A1. Sustainable Development Goals (SDGs) (UN, 2015)

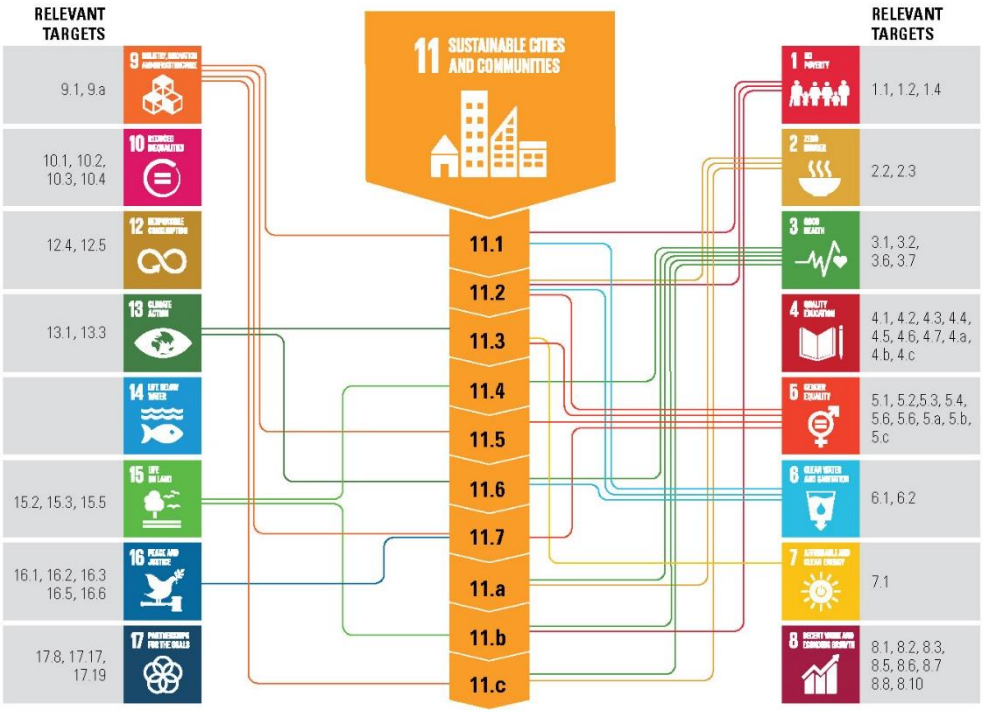

Figure A2. SDG 11 and its connections with the other SDGs (UN, 2018)

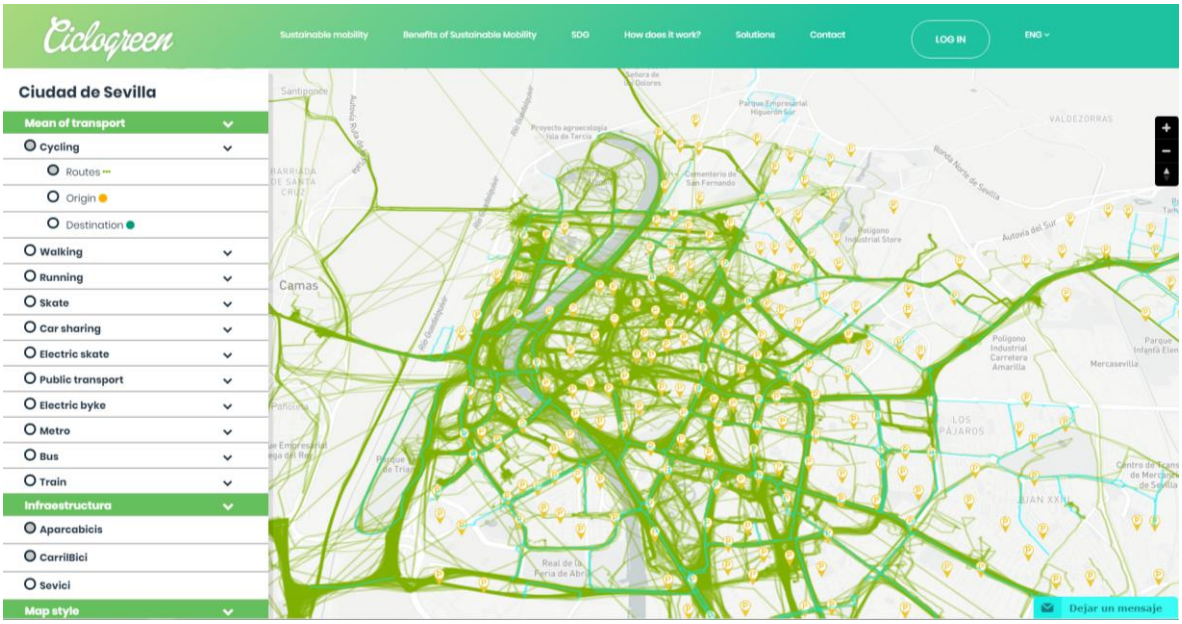

Figure A3. Bicycle routes as identified through users' trips – Sevilla, Spain (Ciclogreen, 2020)

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