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Denmark's perspectives on the implementation of an alternative transport system in the framework of Sustainable Development Goal 11: Sustainable Cities and Communities

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Abstract

As a consequence of excessive consumption of fossil energy intended for transportation, many cities see their air quality worsened, with insufficient basic urban services and infrastructure. To address these challenges, Goal 11 of the United Nations Sustainable Development Goals deals with sustainable cities and local communities. Thanks to its geographical and physical characteristics, Denmark has put in place a unique and ecological transport system: the bicycle system. Based on a qualitative analysis of the UN indicators for Targets 11.2 and 11.6, this report aims at presenting an overview of how Denmark is making progress in the achievement of SDG 11, and tries to give inspiration to other countries to use alternative means of transport, taking into account the different levels of success and failure that this country has had to face.

Keywords: United Nations, Sustainable Development Goals, Goal 11: Sustainable Cities and Communities, Denmark, alternative transportation systems.

Resum: *Perspectives de Dinamarca sobre la implementació d'un sistema de transport alternatiu en el marc de l'Objectiu de Desenvolupament Sostenible 11: Ciutats i Comunitats Sostenibles*

Com a conseqüència del consum excessiu d'energia fòssil destinada al transport, la qualitat de l'aire de moltes ciutats empitjora, amb infraestructures i serveis urbans bàsics insuficients. Per abordar aquests desafiaments, l'Objectiu 11 dels Objectius de Desenvolupament Sostenible de les Nacions Unides s'ocupa de les ciutats sostenibles i de les comunitats locals. Gràcies a les seves característiques geogràfiques i físiques, Dinamarca ha sabut establir un sistema de transport singular i ecològic: el sistema de bicicletes. Basat en una anàlisi qualitativa dels indicadors de l'ONU per a les Fites 11.2 i 11.6, aquest informe té com a objectiu presentar una visió general de com Dinamarca està progressant en l'assoliment de l'ODS 11, i tracta d'inspirar a altres països perquè utilitzin mitjans de

transport alternatius, tenint en compte els diferents nivells d'èxit i fracàs a què aquest país ha hagut d'enfrontar-se.

Paraules clau: Nacions Unides, Objectius de Desenvolupament Sostenible, Objectiu 11: Ciutats i Comunitats Sostenibles, Dinamarca, sistemes de transport alternatius.

Resumen: ***Perspectivas de Dinamarca sobre la implementación de un sistema de transporte alternativo en el marco del Objetivo de Desarrollo Sostenible 11: Ciudades y Comunidades Sostenibles***

Como consecuencia del consumo excesivo de energía fósil destinada al transporte, la calidad del aire de muchas ciudades empeora, con infraestructuras y servicios urbanos básicos insuficientes. Para abordar estos desafíos, el Objetivo 11 de los Objetivos de Desarrollo Sostenible de las Naciones Unidas se ocupa de las ciudades sostenibles y de las comunidades locales. Gracias a sus características geográficas y físicas, Dinamarca ha sabido establecer un sistema de transporte singular y ecológico: el sistema de bicicletas. Basado en un análisis cualitativo de los indicadores de la ONU para las Metas 11.2 y 11.6, este informe tiene como objetivo presentar una visión general de cómo Dinamarca está progresando en el logro del ODS 11, y trata de inspirar a otros países para que utilicen medios de transporte alternativos, teniendo en cuenta los diferentes niveles de éxito y fracaso al que este país ha tenido que enfrentarse.

Palabras clave: Naciones Unidas, Objetivos de Desarrollo Sostenible, Objetivo 11: Ciudades y Comunidades Sostenibles, Dinamarca, sistemas de transporte alternativos.

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1. Introduction

At the present time, the world population is approximately 7.5 billion,[1] a figure that has multiplied by two in the last fifty year and that is expected to reach 9.8 billion people in the year 2050. Among many other consequences, this exponential growth of the world's population has caused a drastic increase in the energy consumption of industries, households and means of transport from all around the world.

The vast majority of this consumed energy comes from the burning of fossil fuels, such as oil, gas or coal, which is the cause of three major global problems. First, the main effect of using fossil energy is the depletion of natural resources. Our planet has a limited capacity to generate raw material. If we consume these resources at a faster rate than nature is capable of regenerating, territorial conflicts for the supply of these resources can arise, leading in many cases to geopolitical tensions that end in war. Second, the use of fossil energy

1. Data as of April 2019, according to the estimates elaborated by the United States Census Bureau.

produces the degradation of the environment by generating a concentration of greenhouse gases far superior to what the planet can process. This causes deforestation, desertification, a gradual increase of the global temperature and pollutes the air we breathe. Last but not least, the dependence on the consumption of non-renewable fossil fuels implies an increase in the cost of living. The scarcity of resources means that only a percentage of the world's population can cover all their needs, which is why inequalities, criminality and social revolt increase.

The serious consequences of this overpopulation and excessive consumption of fossil energy, both for the environment and public health, as well as for the economic and social development, have set off the alarms of a multitude of international organizations, citizens and governments from all over the world, which now have to deal with the effects of what is perhaps the greatest challenge to which humanity has ever had to face. At the international level, the United Nations has promoted various agreements and initiatives in the recent years with the aim of remedying this situation. In June 2012, the city of Rio de Janeiro hosted the United Nations Conference on Sustainable Development (UNCSD) as a 20-year follow up to the United Nations Conference on Environment and Development (UNCED). In that event, the experience acquired through the Millennium Development Goals (MDGs) and the Agenda 21 was used to establish the basis for a subsequent negotiation that resulted in the approval of a new global agreement: the 2030 Agenda. Fifteen years after the implementation of the MDGs, 193 member states of the United Nations approved this programme, which sets out the current Sustainable Development Goals (SDGs). Also known as the Global Goals, these SDGs are an action plan aimed at ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity. They establish 17 goals and 169 targets based on the MDGs, and include new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities.

According to statistics, the economic sector that consumes more energy in our society is transport. Only in the European Union, it accounts for around a third of all final energy consumption, most of which comes from oil (European Environment Agency, 2019). This means that our way of traveling is also responsible for the vast majority of greenhouse gas emissions into the atmosphere. Transport plays a vital role in society and the economy. Our quality of life depends on an efficient and accessible mobility system. However, ending with CO_2 emissions to the atmosphere, improving air quality in cities and making transportation accessible to everyone is not an easy task. The United Nations strategy for 2030 is precisely focused in this direction and pursues, in its Goal 11, making transport systems in cities and communities sustainable.

One of the countries in the world that has best integrated a sustainable transport system into its mobility model is Denmark. This small European state, thanks to its geographical and physical characteristics, has put in place

a unique and ecological transport system. Known for its long and strong democratic trajectory, Denmark has also managed to become a world reference in ecological and environmental issues. It is for this reason that this report will present an overview of how Denmark is making progress in the implementation and achievement of Goal 11 of the SDGs. The qualitative research conducted in this paper will be based on an extensive literature review of academic articles, history books and local and national newspapers on sustainable development and alternative means of transportation. As the main objective of this report is to present the measures taken by Denmark, the study will be also deepened with a quantitative analysis of complementary statistical data provided by national and international databases. Ultimately, through the study of the United Nations indicators for Targets 11.2 and 11.6, this paper will give an analysis that will try to give inspiration to other countries to use alternative means of transport, taking into account the different levels of success and failure that Denmark has had to face when implementing it, especially in the city of Aarhus.

2. Denmark

The Kingdom of Denmark is a constitutional monarchy that consists of three autonomous countries: Denmark, the Faroe Islands and Greenland,[2] which makes it one of the largest states in Europe. All three countries are committed to the 2030 Agenda as a whole, and report jointly to the United Nations High-Level Political Forum on Sustainable Development. However, each autonomous country within the Kingdom has its own political reality and is in a different phase of the SDGs implementation. It is for this reason that this report will only analyze how Denmark is addressing Goal 11, understanding Denmark as the metropolis located on the European continent and not as the Kingdom of Denmark as a whole.

Denmark is a small sovereign state member of the European Union. Despite being a parliamentary monarchy, Queen Margrethe II does not enjoy a real executive power, and popular sovereignty is represented in a unicameral parliament, the *Folketinget*. Denmark is recognized for being one of the most democratic and equal countries in the world. In 1924, it was the first country in the world to have a female minister,[3] and one of the few countries to have a current female head of government.

Since 1909, no political party has obtained an absolute majority, which has meant that all legislative periods have been characterized by the use of pacts

2. Both the Faroe Islands and Greenland enjoy internal autonomy since 1948 and 1979, respectively. Each of these territories has two seats in the Danish Parliament. And, although none of them is part of the European Union, they maintain certain special agreements (Ministerio de Asuntos Exteriores, Unión Europea y Cooperación, 2019).

3. Nina Bang was appointed Minister for Education in 1924, and thereby she became the first female minister in an internationally recognised government (Ministry of Foreign Affairs of Denmark, 2019).

and consensus.[4] For this reason, it is not surprising that, according to the 2018 Corruption Perceptions Index, Denmark is the least corrupt country in the world (Transparency International, 2018).

The 20th century has been dominated by the Social Democratic Party, period during which Denmark has been building a remarkable welfare society that is based on two main pillars: high tax pressure, but with a very strong social security (Ministerio de Asuntos Exteriores, Unión Europea y Cooperación, 2019). The absence of unilateral political majorities has translated as well into energy, economic, social and educational policies, regardless of the party that governed at the time.

In environmental issues, Denmark is also a pioneer. It was the first country in the world to establish a Ministry of Environment back in 1971 (Ministry of Foreign Affairs of Denmark, 2019), and currently headquarters the European Environment Agency (EEA) in Copenhagen. Thus, even center-right governments like that of former Prime Minister Lars Løkke Rasmussen, have supported and promoted measures aimed at reducing CO_2 emissions and at consolidating Denmark's image as a "green" country (Ministerio de Asuntos Exteriores, Unión Europea y Cooperación, 2019).

2.1. Aarhus, the youngest city

Aarhus (officially spelled Århus until 2010) is the second largest city in Denmark and one of the first to have been established in Scandinavia. It sits on the eastern edge of the Jutland peninsula, about 190 km from Copenhagen.

Originally called *Aros*, the city was built by the Vikings to make it a permanent trading place. Its privileged location in the center of Denmark allowed commercial exchanges within the whole country, Germany, the Baltic countries, and later with all of Western Europe. Aarhus remained small until the end of the 19th century, when it began to grow rapidly during the Industrial Revolution thanks to its natural harbor that favored new trade routes (Parrott-Sheffer, 2019).

Today, Aarhus is at the cultural, economic and architectural core of the region and the largest center for trade, services and industry in Jutland (Parrott-Sheffer, 2019). In 2017 it was chosen as the European Capital of Culture. The city is also a centre for research and education, and home to Aarhus University, Scandinavia's largest university. Of its more than 340,000 inhabitants, almost 50,000 are aged under 18 and the average age is 37, which makes it the youngest city in Denmark (Danmarks Statistik, 2018). Thus, Aarhus is the ideal place to implement environmental policies among the new generations.

4. For instance, Lars Løkke Rasmussen, the former Prime Minister, only needed 10 days to form a government in 2015 (a usual time lapse in Denmark, almost always governed by minority governments) (Ministerio de Asuntos Exteriores, Unión Europea y Cooperación, 2019).

3. Goal 11: Sustainable cities and communities

Nowadays, 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050 (United Nations, Department of Economic and Social Affairs, 2018). According to the United Nations estimates, the gradual shift in residence from rural to urban areas, combined with the overall growth of the world's population, could add another 2.5 billion people to the metropolis, especially in Asia and Africa (United Nations Department of Economic and Social Affairs, 2018).

As a consequence of this massive urbanization, many cities see their air quality worsened, with insufficient basic urban services and infrastructure. It is estimated that, since 2016, 90% of urban dwellers have been breathing unsafe air that did not meet the safety standards established by the World Health Organization (WHO), which caused a total of 4.2 million deaths worldwide due to air pollution (United Nations, 2019).

It is not possible to achieve sustainable development without radically transforming the way we build and manage urban spaces. Therefore, better urban planning and more efficient transport systems are needed. To address these challenges, Goal 11 of the SDGs deals with sustainable cities and local communities. More precisely, it concerns "making cities, communities and human settlements inclusive, safe, resilient and sustainable".

In the built environment of cities, a wide range of actors (such as the state, municipalities, citizens and companies) are involved in the interaction with the physical, social and cultural parameters, and with nature. Moreover, cities and local communities face the greatest challenges and opportunities when it comes to generating environmental development (Hildebrandt, 2019). Because the future will be urban for a majority of people, the solutions to some of the greatest issues facing humans, such as poverty, climate change, healthcare or education, must be found in city life. In fact, towns and local communities are prime illustrations of how the involvement of all these agents can help build sustainable cities. This is precisely why Goal 11 provides a good example among the highly political global goals with broad relevance: it is a global goal that requires adaptation to local conditions.

To make the Goal 11 more specific, the UN has defined seven targets. They range from housing, transport and green urban spaces to natural disasters, environmental impacts and cultural heritage. Targets A, B and C constitute a special category of targets that deal with the resources to be deployed to achieve the global goal (Hildebrandt, 2019). For the development of this report, only the following transport targets will be analyzed:

> 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"

> Target 11.6 "By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management"

The monitoring and review mechanism that the United Nations has established to measure the level of implementation of the 2030 Agenda for Sustainable Development is a series of indicators and statistical data, which enables comparisons between countries. In relation to targets 11.2 and 11.6, the most relevant indicators when determining the degree of implementation of a sustainable transport system in a country, which are the ones that will be used in the analysis of this report, are the following:

> Indicator 11.2.1 "Proportion of population that has convenient access to public transport, by sex, age and persons with disabilities"

> Indicator 11.6.2 "Annual mean levels of fine particulate matter in cities"

Transport is the largest end user of energy in developed countries and the fastest growing one in most developing countries (United Nations Human Settlements Programme, 2018). For this reason, sustainable transport is a key ingredient for the achievement of most SDGs, particularly those related to education, food security, health, energy, infrastructure and environment (United Nations Human Settlements Programme, 2018).

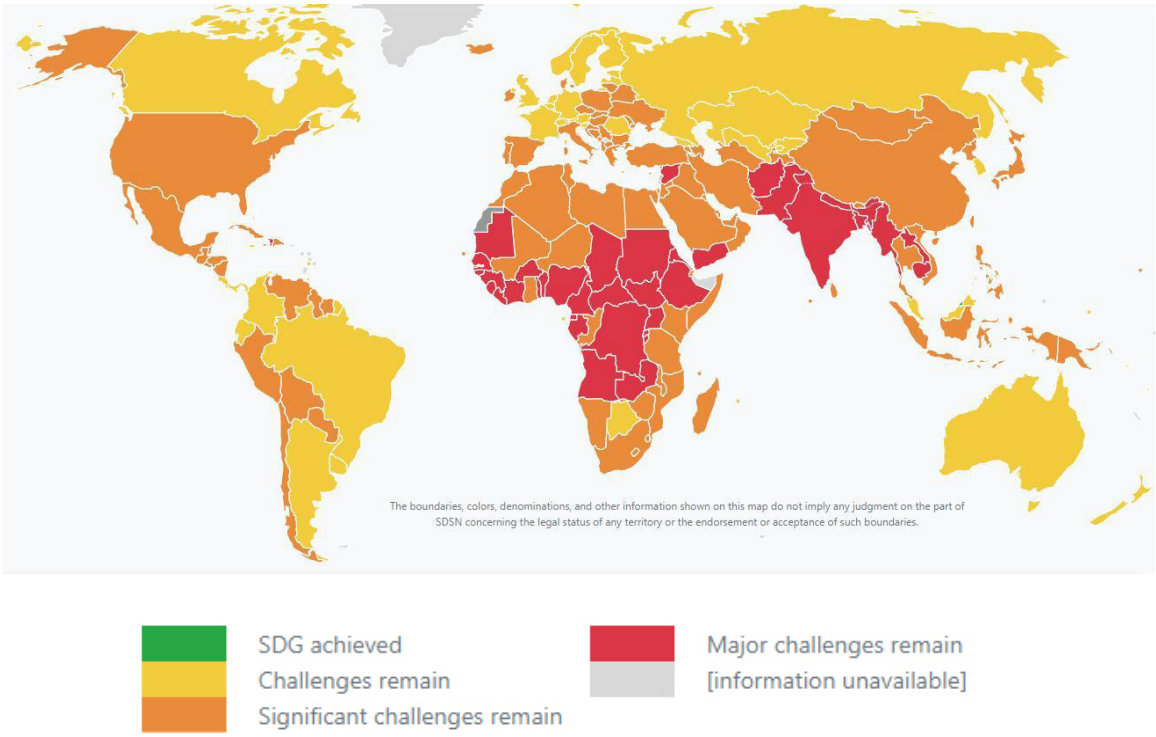
For urban transport to contribute substantially to the attainment of the SDGs, it should adopt urban sustainable models which will produce social, economic and environmental benefits enjoyable by all today and for future generations (United Nations Human Settlements Programme, 2018). Although there is no official description of the United Nations that determines how transport should be, there is a general consensus on what constitutes sustainable transport. This should be: (1) safe, (2) affordable, (3) accessible, (4) efficient, (5) resilient, and (6) climate responsive.

3.1. Global situation

According to the SDG Index and Dashboards Report from 2018, no country is on track towards achieving all SDGs. The SDG Index score signifies a country's position between the worst (0) and the best (100) target outcomes. In accordance with these values, even countries that perform well on the Index score significantly below the maximum score of 100. And what is more worrying, every country scores "red" on at least one SDG in the Dashboards.

Regarding the global situation towards Goal 11, it must be said that no country has met the objectives (fig. 1). Exposure to air pollutants is one of the global environmental challenges of the 21st century that is largely beyond the control of individuals. Such pollution affects everyone, regardless of geography or social status, and thus requires urgent action by public authorities at the regional, national and international levels.

Figure 1. Index Score of Goal 11. Sustainable cities and communities



Source: Bertelsmann Stiftung & Sustainable Development Solutions Network. (2018). SDG Index and Dashboards Report 2018. Global Responsibilities. Implementing the Goals. Retrieved from: *https://dashboards.sdgindex.org/* [accessed April 15th 2019]

Different initiatives have been implemented at a global level. For instance, between 2011 and 2015, the UN-Habitat, in close collaboration with governments and local authorities, implemented a project called "Promoting Sustainable Transport Solutions for East African Cities" (United Nations Human Settlements Programme, 2018). This project aimed to reduce traffic congestion and greenhouse gas emissions in three East African capitals: Addis Ababa (Ethiopia), Kampala (Uganda) and Nairobi (Kenya). However, despite the efforts, these three countries remain, today, without having achieved the desired minimum goals.

In short, despite significant progress during the Millennium Development Goals (MDGs) period, making cities, communities and human settlements inclusive, safe, resilient and sustainable remain major challenges in most countries.

3.2. Regional situation

From a regional point of view, the Nordic countries have been assessed as being among the top most "SDG-ready" countries in the world and are all ranked in the top ten of the 2018 SDG Index and Dashboards Report. Sweden is in the No. 1 position, Denmark in the No. 2, Finland in the No. 3, Norway in the No. 6 and Iceland in the No. 10.

On September 2017, the ministers of the five Nordic countries, together with Åland, Greenland and the Faroe Islands, adopted the "Generation 2030" programme, a joint programme of Nordic Co-operation for the implementation the 2030 Agenda and its 17 SDGs.

The Nordic countries, including their autonomous regions, have a long tradition in advancing the goals of sustainable development individually, at the national, level as well as jointly, at the international level. The launch of the United Nations Environment Programme in Stockholm in 1972; the formulation and launch of the already "classic" definition of sustainable development in the Brundtland report; the important Nordic input into the Rio summit in 1992; or the launch of the first Nordic Strategy on Sustainable Development in 2001 are examples of their involvement in the scope of sustainable development. As such, it is no surprise that a majority of SDG targets are, in practice, relevant for the Nordic countries and are already expressed in the fourth and current Nordic Strategy for Sustainable Development, adopted in 2013.

The Generation 2030 programme emphasises the involvement of children and young people as agents of change. The aim is not to co-ordinate the national implementation of the SDGs, but to contribute to their realisation by way of relevant analyses, knowledge sharing and debate, through the involvement of Nordic civil society organisations, the private sector, research networks, and youth organisations in the Nordic Region (Nordic Council of Ministers, 2017). With Generation 2030, the Nordic countries place special emphasis on the common challenges they face with regard to their achieving the 17 SDGs, especially in those goals where they are not making significant progress, as it is the case of sustainable consumption and production.

4. Denmark's position vis-à-vis Goal 11

As stated above, no country is on the track to reach all 17 Goals by the year 2030. Nevertheless, Denmark is the second country in the world, after Sweden, to have accomplished a greater number of achievements in this direction, especially in education, health and gender equality.

Analyzing Goal 11 in relation to Denmark is interesting because this country has great potential to take a leading position. Denmark is already internationally recognised for its innovative design solutions –a recognition that spans its urban

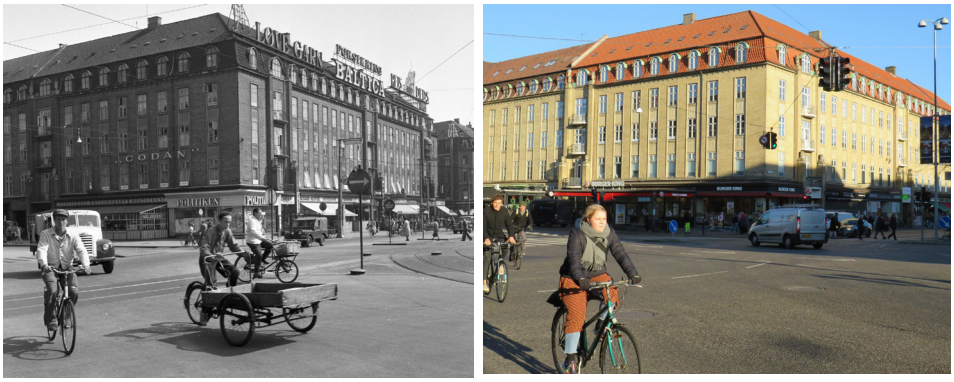
and rural architectural solutions to bicycle paths to its people-centric climate adaptation initiatives. Therefore, this next section will analyze those measures that Denmark has implemented to achieve a sustainable transport system and that can inspire other countries, and also those measures that have not been so successful and that may pose a challenge for the country.

4.1. Historical analysis and precedents

During the 1920s and 1930s, the bicycle became a widely accepted representative of equality and freedom. The 1950s, characterized by the boom of the automobile and the motorcycle, made the most important cities of the world redesign their streets and adapt their roads to these new motorized means of transport, leaving bicycles behind (Ministry of Foreign Affairs of Denmark, n.d.). Practically all over the world, these two-wheeled structures began to relate more to a sports practice than as a proper means of transport. However, Denmark was one of the few countries that did not consider it as a simple leisure tool, but rather did not stop using the bicycle as an ideal instrument for day-to-day mobility.

Throughout all these decades, the Danes, managed to adapt their cities and their lives to bike's usage, until becoming today the second country in the world with the highest proportion of bicycle use as a percentage of total number of trips, after the Netherlands (Harms; Kansen, 2018). Although advantaged by its plains and lowlands, Denmark is now a model of success that integrates very well cycling as part of its own culture (fig. 2).

Figure 2. Historical comparison of the use of bicycles in Aarhus



On the left side, a cyclist with a fishing coach carriage along with other cyclists. On the right side, several cyclists and vehicles circulating together. Both photographs were taken at Banegårdspladsen, Aarhus, in the years 1954 and 2018, respectively. They show how, for more than 60 years, the Danes have used the bicycle as an alternative means of transport in their daily lives.
Sources: Left: Venge, Børge A. (May 26th, 1954). Gl. Fisker bil & cyklister. Århus Stiftstidendes fotosamling (1937-2000), Aarhus Arkivet. Right: Blin Domínguez, Fiona. (November 27th, 2018) *Cyclists Banegårdspladsen, Aarhus*.

4.2. Current situation

4.2.1. Main indicators, figures and data

Denmark has an approximate population of 5.7 million inhabitants (Danmarks Statistik, 2018), of which 47% of men and 53% of women use the bicycle as a day-to-day vehicle to go to work, school or shopping. Almost 26% of trips shorter than 5 km, and 16% of all trips, are done by this means of transport (Cycling Embassy of Denmark, 2018), which represents that a Dane cycles on average 1.6 km a day, which is 16 times more than a Spaniard, the European citizen who uses the bike the least (European Economic and Social Committee, 2010).

This mobility system that the Danes have created and integrated has numerous benefits, both for the environment and for health, as well as for the economy and the society of the country. Below, several advantages of using the bicycle as a daily alternative means of transport, as well as some results that the Danes have obtained from this practice, will be examined.

Environment

Today, the fuel car remains the most widely used means of transport in Europe, representing 70% of the total trips of EU citizens, a number that continues to increase each year despite the release of electric cars in the market (European Environment Agency, 2016). This growth is not negligible, since cars produce pollutants in two different stages of their existence: it starts with their production, a high-energy industrial process that accounts for 42g of CO_2 emissions per kilometer driven; and continues with its circulation and consumption of diesel, which leads to the emission of 271g of CO_2 per passenger and kilometer (European Cyclists' Federation, 2013).

The bicycle as a means of transport, on the other hand, only generates pollution in the first stage, since the energy that makes it move is the human force. The production of a bicycle accounts for only 5g of CO_2 emissions per kilometer driven, which is about nine times less than compared to the production of a car (European Cyclists' Federation, 2013). Therefore, we can say that the bicycle is an environmentally friendly vehicle.

Health & safety

The everyday use of the bicycle as a vehicle to go to work or school instead of driving a car has other advantages too: it is healthier and it is safer. In the first place, it is healthier because, by generating fewer pollutants for its production and emitting no greenhouse gases during its consumption, commuters breathe less toxins. Results from the Mass Experiment in 2012 indicate that children who cycle or walk to school are much better at concentrating in their studies compared to children who arrive to school by car, bus or train (Cycling Embassy of Denmark, 2018). In addition, it has been proven that cycling significantly

reduces the risk of suffering from various illnesses such as cardiovascular diseases, diabetes, obesity, depression and some types of cancer, among others (De Hartog *et al*., 2010). And in second place, cycling is safer than driving because there are almost 4 times fewer deaths caused by bicycle collisions than by car accidents (table 1).

Table 1. Number of individuals killed in road traffic accidents in Denmark in 2017

Killed by:	**Number**
Ordinary private car	104
Lorry, total weight over 3.500 kg	2
Bus	0
Motorcycle	11
Moped with registration max. speed 45 km p.h.	1
Other mopeds	8
Bicycle	27
Pedestrian	20
Others	2
Total	175

Source: Danmarks Statistik (2017)

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Economy

Using the bicycle as an alternative means of transport or even as a main vehicle has three main economic advantages. First of all, it is beneficial for the consumer because it is much cheaper than a car. It is calculated that in Europe, the average purchasing price of a new bicycle is 579 euros, more than 30 times less than that of an average car (European Economic and Social Committee, 2010). In addition to that, the owner of a bicycle saves the high cost of maintaining a car, as well as the parking space or the insurance.

Secondly, the fact that a very large sector of the population owns bicycles is positive for the national economy. A country like Denmark, which does not produce its own cars but instead designs and manufactures its own bicycles, favors national companies. In this sense, it is estimated that approximately half a million bicycles are sold each year in Denmark (Cycling Embassy of Denmark, 2018).

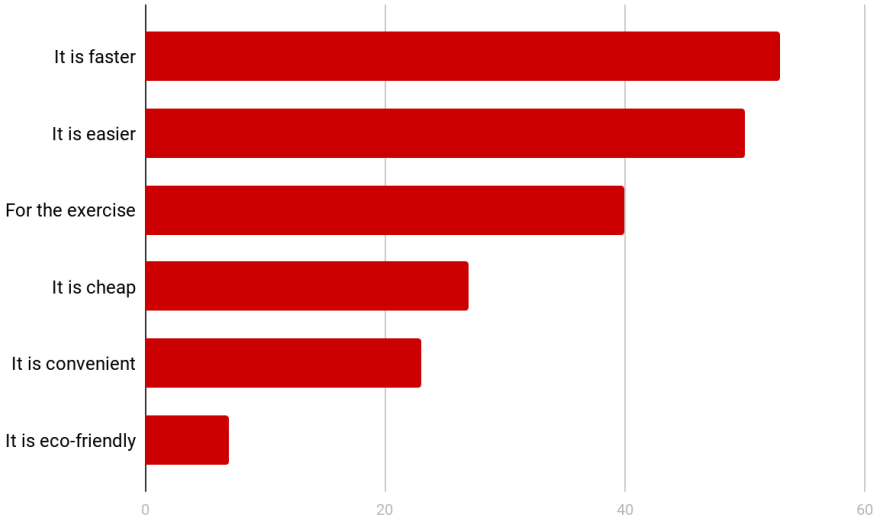
Finally, as seen above, cycling regularly to work or school is beneficial for physical and mental health, and consequently is cheaper for the health system.

Time efficiency

On average, each European driver spends 28.25 hours every year in road congestions (European Commission, 2018), something that the Danes do not like at all. For them, work-life balance is much more important, and prefer to spend time with their families or practicing a sport than to waste it on the roads.

Compared to cars, bicycles take up little space and are more manageable. For that reason, its use for short distances is simpler and faster. In metropolitan and urban areas, it is also much easier to park a bicycle than a car. In addition, at peak times in large cities it is simpler to calculate how long it will take to make a trip by bike than by car or public transport. In this sense, it is not strange that the citizens of the Danish capital consider that the main reason for using the bicycle as a means of transport is that it is faster (fig. 3).

Figure 3. Copenhageners' reasons for cycling



Source: The Technical and Environmental Administration of the City of Copenhagen (2017)

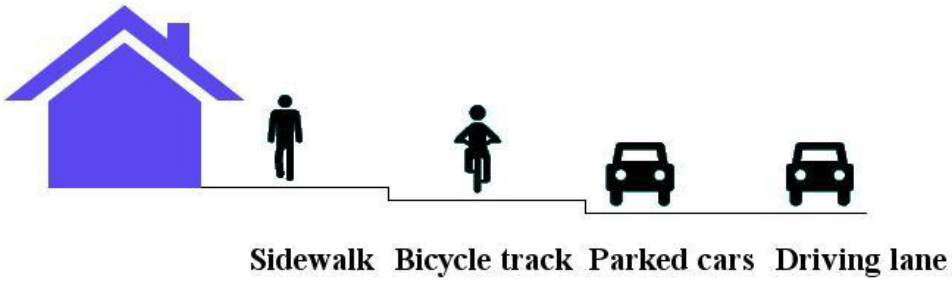
Happiness

Cycling is a practice often related to freedom and serenity. People who walk or bike to work tend to feel more relaxed and less stressed, they are more satisfied with themselves and experience a greater sense autonomy compared to people who drive their car to work. The use of bicycle as an alternative means of transport, as stated before, not only improves physical health, but also has a positive impact on subjective well-being. Furthermore, bicycle is a silent means of transport, which exercised in contact with nature, as for example in a forest or in a city park, can be related to a feeling of joy.

4.2.2. Adopted measures

In order for citizens to travel in a cleaner, faster, simpler and safer way, over the years, more than 12,000 km of cycle tracks and lanes have been installed throughout Denmark (Cycling Embassy of Denmark, 2018), of which a large part are integrated into a unique transport system of separated bicycle tracks that makes biking safer (fig. 4).

Figure 4. Design scheme of the Danish separated bicycle tracks



Source: Cycling Embassy of Denmark. (2018). Design scheme of the Danish separated bicycle tracks. *Facts about Cycling in Denmark*.

In addition to having these roads prepared and adjusted to commuters, the State continues to invest in improving and adapting infrastructures to demographic and technological changes. Thus, in June 2014, the Danish government allocated, again, funding for cycling. It invested a total of 180 million kroner on providing more cycle superhighways and better bicycle parking facilities; 175 million kroner for new initiatives on both the state roads and local roads; and 21 million kroner for measures to prevent right-turn accidents (Transportministeriet, 2014). These following are a series of elements and infrastructures implemented, both nationally and locally, to the Danish transit system:

– *Access to a public bicycle rental service*: Although the majority of Danes are owners of one or more bicycles, the city councils of the big cities, such as Aarhus, offer a bicycle rental service (fig. 5a). Through a mobile application, those people (locals or tourists) who wish to take a bike ride for a few hours can do so at reduced prices.

– *Exclusive lanes for bicycles*: Despite having separated bicycle tracks on roads, the Danes are also pioneers in the construction of exclusive bicycle lanes in areas where it is physically impossible to build roads. An example of this is the *Cykelslangen* ("the bicycle snake") path of Copenhagen that rises above the water (fig. 5b). With its 235 meters of length, it allows travelling directly from the Dybbølsbro bridge to the harbor bridge Bryggebroen, in a faster and safer way.

– *Parking spaces in public areas and shops*: As Denmark is one of the countries in the world with the largest number of bicycles, numerous squares and large streets of Aarhus and Copenhagen offer parking spaces for commuters to leave their vehicles while they are working or go shopping. In addition, for cold and bad weather days, some shopping centers and galleries have included indoor parkings (fig. 5c).

– *Bicycle access to public transport*: In order for a country to sustain its cyclist mobility system, it needs public transport and its accesses to be adapted to bicycles so that commuters can travel longer distances. An example of this is the Central Station of Aarhus. On the one hand, it has a large covered parking that gives direct access to the tracks (fig. 5d); and on the other hand, train carriages are equipped to accommodate bicycles (fig. 5e).

– *Bicycle counters*: In cities like Aarhus and Copenhagen, bicycle counters have been installed (fig. 5f). Thanks to mobile applications, commuters can know what the influx of traffic is in real time, and so they can decide which is the fastest way to get to their destination. In addition, these machines allow to obtain statistical data that the State then collects in order to improve roads that collapse easily.

– *Access to air pumps and electric chargers*: Bicycles are machines and, therefore, need some maintenance. To this end, most Danish cities have air pumps installed in their streets (fig. 5g). With the increase in the use of electric bicycles, many parkings also have special electric bike chargers (fig. 5h).

4.2.3. Main actors involved

Promoting the use of a new vehicle as a fashion product, such as an electric scooter or a *Segway*, into a society at a given time can be quite simple for a marketing company. However, promoting the use of an old means of transport such as bicycle, which must also involve a physical effort for the commuter, is an arduous job for a state.

Rome wasn't built in a day. Implementing a transport system that combines the use of classic motorized vehicles with alternative manual cycles in an increasingly technological society, involves a lot of time and resources. Denmark, in order to integrate cycling as part of its own culture and the collective imaginary of the country, has taken decades to achieve it.

The success of cycling does not depend on poverty, dictatorial regimes or the lack of motorized transport options to force people onto bikes (Pucher; Buehler, 2008:497), but rather on the contrary: it depends on the resources that a state spends on the implementation of this system. Below, the main actors involved in the implementation of this sustainable transport system in Denmark will be examined.

Figure 5

a: "Pendlercykel" service in the city of Aarhus. Source: image taken on November 27th, 2018 at Banegårdspladsen, Aarhus.
b: Views of the Cykelslangen of Copenhagen. Source: image taken on December 3rd, 2018 at Kalvebod Brygge, Copenhagen.
c: Interior parking of Fisketorvet Shopping Center of Copenhagen. Source: image taken on December 3rd, 2018 at Havneholmen, Copenhagen.
d: Bicycle parking of the Central Station of Aarhus. Source: image taken on November 27th, 2018 at M. P. Bruuns Gade, Aarhus.

e

f

g

h

e: Aarhus train with bicycle signal. Source: image taken on November 27th, 2018 at Central Station, Aarhus.
f: Bicycle counter in Aarhus. Source: image taken on December 11th, 2018 at Frederiks Allé, Aarhus.
g: Air pump in Aarhus. Source: image taken on December 11th, 2018 at Sønder Allé, Aarhus.
h: Electric chargers in the bike parking of Fisketorvet Shopping Center of Copenhagen. Source: image taken on December 3rd, 2018 at Havneholmen, Copenhagen.

Supranational actors

Both states and supranational structures use mechanisms, such as the promotion of policies or the establishment of laws and rules, to achieve certain social and economic objectives. Without these regulations it would be practically impossible to achieve these goals and integrate them into society. Due to the mostly local, short-distance trips made by bike, policies and programmes to promote safe and convenient cycling are usually carried out at the municipal level. However, the recent international awareness for climate change has resulted in the creation of supranational policies that are aimed at combating the emission of polluting gases as well as using clean means of transport.

An example of a Danish policy derived from supranational recommendations is the new national bicycle strategy from 2014, called *Denmark – on your bike!*, which aims at encouraging more people to cycle in order to become more 'green'. Although Denmark is already one of the world's leading bike-using countries, it has been detected that Danes use bicycles less than their ancestors (Transportministeriet, 2014). Thus, the scope of this new cycling strategy is divided into three focus areas: everyday, school and recreational cycling, areas that are intimately linked to the three points that will be analyzed below.

National actors

As it is well known, Denmark is one of the countries in the world with the highest taxes, a measure that not only serves to finance the education or health system, but also serves, among other things, to reduce the consumption of certain goods, like cars. The first national measure aimed at reducing the use of pollutant cars was to tax Danish car owners. This first policy dates back to 1910, when the government implemented a taxation for driving on public roads. Then from 1924, the government put a tax on the import of 'luxury items' (including vehicles), that is still in force today: the current Nordic nation's Vehicle Registration Tax (*Registreringsafgift*). With this, in order to register their vehicle, Danes must pay approximately 105% of its value for vehicles bought for under 81,700 kroner, and 150% of the value for vehicles bought for over this price (Barrett, 2015), a strategy that, willingly or unwillingly, has made many Danes think twice before purchasing a new car.

And the second effective measure, that differs from that adopted by other countries, is the establishment of very strict national cycling rules that are deeply integrated with the traffic code. The establishment of fines for the breach of these rules is not an impediment to the development of the use of bicycles in Denmark, rather they serve so that cyclists, vehicles and pedestrians circulate with greater freedom and safety.

Regional and local actors

It is said that education is a fundamental pillar for the development of a country. And it seems to be true, because without an inculcation from school

and family of good healthy habits and respect for rules and regulations relating to cycling behavior, Denmark might not be today the second country in the world with the highest proportion of bicycle use, and all the policies and laws would have been in vain. «It is not a coincidence how many cyclists can be found in a city or a country. It depends entirely on the efforts made in the area. In Denmark, much has been done to cater for cyclists over the years. A list of motivating and activating cycling campaigns has helped pave the way for the strong bicycle culture in Denmark» (Cycling Embassy of Denmark, 2011, p. 24), both at school and university level.

At a first level, Danish schools, for years now, have implemented an integrating learning system through which they connect children with bicycles. Every year when a child starts school for the first time, he is also preparing himself to arrive at the establishment. Traditionally, children are primarily being taught traffic safety. However, at the municipality of Odense, for instance, they also promote bicycling by adding it to the existing curriculum (Cramer, 2016). Thanks to the collaboration between municipalities and schools, children can choose to bike to class in the mornings, which helps to create better cyclists out of a new generation of students. For this reason, it is not strange to see that 49% of Danish children aged 11-15 go to school by bike (Cycling Embassy of Denmark, 2018).

Finally, at a second level, the Danish government, with the help of regional and local administrations, also integrates the cycling culture in universities. For instance, when an exchange student arrives for the first time at the University of Aarhus to spend even one semester, he or she receives an informative brochure designed by the city council with all the rules and prohibitions that must be respected when using the bicycle. In addition, the University itself organizes a small explanatory talk about the cycling culture in Denmark during the first days of stay. This helps foreign students get used to the Danish system of bicycles and to become responsible cyclists.

Private actors

Integrating cycling as part of a country's culture is also adapting to the needs of its citizens. One way of doing this is by designing practical vehicles for the daily life of families and workers. This is when private companies come into play.

Motivated by the need to move all sorts of goodies, during the 1970s the cargo bike, also known as *the Christiania* (fig. 6), was invented in Denmark. Unlike the Dutch two-wheeled bicycles that transported children in the back, this Danish bicycle incorporated an extra wheel in the front in order to adapt a box. This stabilized the bicycle so that the weight that was placed in the box, whether children or goods, did not cause the vehicle to tip over. Over the years, these bicycles have been evolving a lot, so now adaptations of four basic models are used: bikes with seats for children, with rain guards, with sun shields, adapted to transport goods, designed to carry pets, and a long etcetera.

Figure 6. Young lady carrying a child in a cargo bike or "Christiania" on a rainy day in Copenhagen

Source: image taken on December 3rd, 2018 at Fiolstræde, Copenhagen.

4.2.4. Results of the adopted measures

Levels of success

Thanks to the measures implemented by the supranational, regional and local levels, as well as the private sector, Denmark has managed to implement a sustainable bicycle transport system, whose biggest beneficiaries have been citizens.

In the first place, from an environmental point of view, we can say that the implementation of the measures adopted has been a success because atmospheric pollution has been reduced. In Copenhagen, for instance, there are 5.6 times more bikes than cars, which are used for the 41% of trips made to work or school (The Technical and Environmental Administration of the City of Copenhagen, 2017). This consequent reduction of greenhouse gas emissions into the atmosphere by the daily use of bicycles has turned the Danish capital into the second European city with the best air quality (European Environment Agency, 2017).

Secondly, the health and safety of Danes have also been favored. In recent years there has been a sharp decrease in the number of diseases caused by cardiovascular illnesses in Denmark, being the number of deaths caused by contracted coronaries 15,597 in 1990 and 3,779 in 2015 (Danmarks Statistik, 2018), one of the largest decrease in Europe in the last 20 years. With regard to security, in 2017 the total number of transit deaths in ordinary private cars in Denmark was 104, while the number of deaths in bicycle was 27 (Danmarks Statistik, 2017).

Thirdly, the country's economy has not stopped badly, since for every kilometer travelled by bicycle instead of by car, Danish society earns approximately 1€ in terms of health benefits (Cycling Embassy of Denmark, 2018). According to the latest analysis conducted by the Confederation of Danish Industry, if cycling in Denmark increased by just 10%, the number

of sick days would fall by 267,000 and 1.137 million kroner would be saved every year.

Finally, the Danes, who enjoy one of the best work-life balances in the world, also use cycling as a social interactive medium with family and friends. It is perhaps for these reasons, among many other possible factors, that the bicycle transport system makes them the happiest people in the world.

Levels of failure

The ambition to create a green transport system such as cycling in the day-to-day life of people requires big efforts and expenses from administrations. As it has been seen, Denmark can boast of its transport model. However, like any political strategy, sometimes this might not be suitable for everyone and may encounter some limitations when it comes to putting it into practice.

The first limitation that Denmark has encountered, and that other countries could face while implementing a similar system, is that of the elderly and people with physical disabilities. Both groups, due to their physical condition, cannot use the bicycle as an alternative means of transport and must look for other solutions, such as the use of private vehicles or public transport. Nonetheless, it seems that there has been a growing trend in the use of bicycles for recreational purposes by people over 60. Two reasons could be the cause: on the one hand, the improvement of the general health of this age group, and on the other, the introduction of electric bicycles in the market (Harms; Kansen, 2018).

The second limitation that the Danes (might) have faced is the cultural and religious barriers when it comes to instilling cyclist culture to foreigners who come to the country for the first time. For instance, some states are not very adept at cycling or even prohibit its use. This is the case of Iran, that practicing the most radical side of Islam, prohibits women from using bicycles. There, women on bikes constitute a threat to morality (The Guardian, 2017), something that is unthinkable for one of the most egalitarian countries in the world in terms of gender equality.[5]

Thirdly, the third reason that could seem a limitation is the weather conditions. Although Denmark has an average of 179 precipitation days per year (Danish Meteorological Institute, 2017), cold and rain does not stop them cycling. Quite the contrary, 75% of bike traffic continues throughout the winter. The only possible explanation is positivism. The Danes just love the saying from the British fellwalker Albert Wainwright: "Der findes intet, der hedder dårligt vejr, kun dårlig påklædning!" ("There's no such thing as bad weather, only unsuitable clothing!").

Last but not least, the implementation of a transport system that requires the impulse and human force can be an inconvenience when making long

5. According to the Gender Inequality Index issued by the UN Human Development Programme, Denmark is the 11th country in the world with the highest human development.

journeys. Likewise, the use of bicycles as a means of transport does not allow carrying bulky nor weighty items. For these cases, other conventional means of transport must be used.

4.3. Expectations for the coming years: towards self-sufficiency

Since the end of the 20th century until now, Denmark has invested many resources to become a pioneer in sustainability. However, despite all the efforts made, the planet is still seriously threatened by the way we consume energy, and all other countries, will have to create new plans and strategies if they want to reach the SDGs before 2030.

In the coming years, Denmark aims to remain at the global forefront of environmental policy. In order to achieve these intentions, in 2018, the government published a series of 38 strong and effective initiatives under the title of "Together for a greener future" to ensure cleaner transport in cities and the countryside, efficient and modern agriculture, more environmentally-friendly shipping, and a green transition in housing and industry. A proposal that calls on all Danes to come together and embrace a shared responsibility for the planet.

In that same sense, already in the year 1997, the Danish ministry of environment and energy put out a challenge to 5 of the country's populated islands to reduce their carbon footprint and increase production of renewable energy. The Municipality of Samsø. a 4,000-inhabitant island nestled in the Kattegat Sea, located about 30 km from the coast of Aarhus, entered and won the contest. The award did not bring with it funds to bankroll the energy transition, but it did pay for the salary of one person tasked with making the island's 10-year renewables master plan a reality. And that person was Søren Hermansen, a Samsø native vegetable farmer and environmental teacher (Lewis, 2017).

In less than a decade, as a result of skillful community engagement, realistic analysis, and deep understanding of local sensitivities, the transformation to carbon neutral was complete and Samsø became the first island in the world to be 100% energy independent and carbon-neutral. By 2000, 11 one-megawatt (MW) wind turbines supplied the island's 22 villages with enough energy to make it self-sufficient (Lewis, 2017). An additional 10 offshore wind turbines were erected in 2002, generating 23 MW of electricity to offset emissions from the island's cars, buses, tractors and ferries that connect it to the mainland. Currently, the island generates more energy than it consumes (Lewis, 2017).

Becoming self-sufficient energetically has not been an easy task. However, in a 2014 interview,[6] Hermansen explains how the community engagement shifted the island from being powered by fossil fuels to wind turbines. At

6. The interview took place in Denmark in October 2014, and was conducted by Canadian journalist and professor Silver Donald Cameron, whose work focuses on social justice, nature and the environment. The extract of the interview can be seen at: https://youtu.be/OvTXtnnLe1Q (accessed 02/05/2019).

first, many doubts arose. «How do we achieve our goals? We need to produce renewable energy. We don't have hydro power, we can't dam our rivers because we don't have any heights in Denmark. [W]e have a lot of wind and we have a lot of biomass!», says Hermansen. Community buy-in was essential to making the zero-carbon master plan a reality. Islanders exchanged their oil-burning furnaces for centralized plants that burn leftover straw or wood chips to produce heat and hot water. They bought shares in new wind turbines, which generated the capital to build 11 large land-based turbines, enough to meet the entire island's electricity needs. «In Denmark it was farm machinery manufacturers that actually took over the wind projects. [T]hey were doing irrigation machines and trailers and tractor equipment and all sorts of things, and then they did some wind turbines on the side», states Hermansen.

Today «we have very decent realized common structure with the municipalities being quite independent for many things», says proud Hermansen. In short, the sustainability project of Samsø Island is the project the Danes hope to see some day in the whole territory of the country. That is to say, a hopeful project of sustainable development that can be implemented at a global scale, through local cooperation and, fundamentally, through political will.

5. Evaluation and recommendations

5.1. General evaluation of Denmark's position vis-à-vis Goal 11

According to the 2017 Global Mobility Report (World Bank, 2017), transport should be climate responsive, efficient, safe and equitable in access, requirements that the Danish bicycle transport system meets.

In the first place, Danish mobility, as previously noted, is a clean system of transport that addresses climate change through mitigation and adaptation. Looking at the emission of Particulate Matter PM 2.5 and PM 10 (the mixture of solid particles and liquid droplets in the air), all levels calculated by the measurement stations around Denmark are below the limit value of what is established by international conventions (Rambøll, 2019). In the second place, the bicycle system is efficient. Transport demand is met at the least possible cost, and optimizes resources to generate an efficient transport network: it is cheap and fast. In the third place, biking in Denmark is safe. All the infrastructures implemented in big cities like Aarhus avoid fatalities, injuries, and crashes from transport accidents. Finally, as far as possible, this alternative transportation system places a minimum value on everyone's travel needs, providing all with at least some basic level of access to transport services in a way that leaves no one behind.

5.2. List of specific recommendations

With this report, we have shown how Denmark is a frontrunner in many areas. However, the analysis also shows that Denmark still has some way to go to fully reach Goal 11 by 2030. This Nordic country is known for its cities' sustainability, but it is not entirely close from building a complete sustainably, nor to reach all ranges of the population with a bicycle transport system now that the population is aging. This is why Denmark must keep working on the SDGs. Drawing on this report, some few specific recommendations for this work have been compiled.

1. **Readjustment of taxes on cars.** Currently at a rate close to 120% (20% VAT + 100% registration), these taxes are supposed to dissuade Danes from buying and using cars as a means of transport. Since Denmark does not have a car industry, this tax does not affect its economy and allows substantial tax revenue on imported products. In the field of reducing automobile pollution, the result seems counterproductive. The exorbitant price of new cars means that the car fleet is not renewed, and therefore that old cars are only slightly replaced by new cars less polluting.

   Pros: a substantial drop in registration taxes would enable the middle classes to access more modern and environmentally friendly car purchases.
   Cons: this drop in taxes could mean a greater purchase of cars, which could eventually lower the use of bicycles.

2. **Increase in the number of charging infrastructures for electric vehicles.** Unlike neighboring Norway, the number of electric cars is low in Denmark. Few public car parks or shopping malls have charging stations for electric vehicles.

   Pros: infrastructure development would be essential for facilitating electric and environmentally friendly mobility.
   Cons: in the long term, it would be necessary to evaluate the impact that the batteries of the electric cars would generate at the end of their life, since the materials from which they are made cannot be recycled.

3. **Replacement of diesel engines of ferries by gas engines.** The 2 most important cities of Denmark (Aarhus and Copenhagen) are connected either by road with toll bridge (300 km) or by road and boat (110 + 80 km). About 1.4 million cars use the road + boat transport each year. 24 trips are organized every day, capable of transporting 10,000 cars (Paxpix, 2018). The boats used are ultra-fast catamarans that can reach speeds of 45 knots (85 km/h). They are powered by turbines driven by 4 diesel engines running on fuel (9000 kW each), highly polluting (Molslinjen, 2019).

Pros: substantial reduction of particulate and sulfur emissions into the atmosphere. Decrease of energy costs.
Cons: high cost of changing engines and tanks. Port infrastructures should be modified (construction of gas tanks).

6. Final remarks

The number of people in the world is increasing progressively and drastically, and so does the consumption of energy. Among all sectors, the one that consumes the most energy is transport, which is responsible for the majority of CO_2 emissions into the atmosphere.

In order to achieve the majority of the Sustainable Development Goals (SDGs), it is necessary to have a sustainable transportation system. Targets 11.2 and 11.6 establish that all citizens must be provided with safe and sustainable access to means of transport, reducing their environmental effects and preserving the air quality of cities.

Despite the fact that no country in the world has fully achieved the 17 Goals, it is worth noting that the Nordic countries are leading the list of the Top 10 aimed at this direction.

At a time when climate change and global warming are part of the international agenda, more and more countries are trying to integrate the use of alternative means of transport into their mobility systems. However, implementing the use of bicycles among the population is an arduous task that requires many years of efforts and the involvement of all administrations. In this sense, only few countries, like Denmark, have been able to implement cycling as part of their own culture.

Despite some limitations that may have been found at the time of introducing cycling into their mobility system, it can be concluded that the Danes can effectively inspire other countries to use alternative means of transport because of all the positive results they have obtained: the Danes breathe cleaner air, have less heart diseases, do not waste time in road congestions, spend less money on transport, make national companies more profitable, and are on average happier than the rest of countries.

As it has been reflected in the analysis, there have been three fundamental elements that made possible the obtaining of these benefits and that could serve as a model for other countries: the implementation of clear sustainability policies and road safety laws; the promotion of cycling culture at local levels, such as in schools and universities; and the establishment of modern, safe and necessary infrastructures.

Denmark is the second country in the world to have reached more objectives of the SDGs. Target 11 has not yet been fully achieved, but it is certain that its sustainable transport system will be a source of inspiration for many other countries, cities and communities.

The broad democratic trajectory of the country, as well as its great capacity to create consensus between the political elites and the social bases, make Denmark a model country for the implementation of environmental policies. The creation of a fully sustainable and energy independent island is the clearest example that it is still possible to combat climate change and that the objectives of international protocols can be met.

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