Sustainable urban development: case study Copenhagen

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https://doi.org/10.53465/EDAMBA.2021.9788022549301.390-399

Abstract: The aim of the article is to explain the concept of a sustainable smart city with a connection to transport and mobility within case study of green European city- Copenhagen which is generally recognized as a leader in the global green economy. In the first part of the article, we first define the general nature of sustainable urban development and then follow up on the essentials of building urban sustainability, including the role of smart sustainable cities in relation to sustainable urban development. In the second part of the article, we will discuss about effective approaches of the selected European city of Copenhagen, through which we specified in more detail by the case study to specify how successful can smart city be built which is connected with urban transport and mobility which is one of the most important aspect that need to be focused on and constantly improved in order to ensure quality and sustainable urban development.

Keywords: Sustainability, Urban development, Smart city.

JEL classification: *Q52, Q58, R58*

1 Introduction

Nowadays, the main challenge for cities is to optimize the strong dependence on ecosystem services, which leads to the depletion of natural resources, the disruption of biodiversity and efforts to adapt to climate change, giving priority to public health and quality of life. The objectives are, in principle, to reduce the carbon footprint of cities and greenhouse gas emissions, focusing on the ways in which resources and energy are consumed in the construction, operation and maintenance of the urban environment. Such an ideal situation can be created when cities build efficient waste disposal systems, green spaces and green buildings, public transport and attract employers producing organic products from local sources for regional markets. The behavior and lifestyle of urban dwellers play the most important role in building sustainable urban development.

2 Definition of methodology and basic directions in the processing of the article, description of the expected methods applied in the processing of the selected topic

The main output of the article is to approach the issue of sustainable urban development, which in its implementation ensures effective planning to achieve the set goals within the framework of improving the environment. To approach the implementation of strategic plans for the development of urban sustainability, we have chosen a specific European city, in which we will discuss the specific ambitions and results that need to be focused on the development of urban sustainability.

In order to be able to approach the issue of urban sustainable development, we defined the basic aspects of urban sustainability, where we subsequently specified the model of a smart city. Through an analysis by a case study of an ambitious European city - Copenhagen, we put the issue of the topic of the article into practice. They explored specific areas - the smart city with a link to urban transport - that needs to be addressed in order to achieve the development of urban sustainability as effectively as possible. As the most specific goal of the city of Copenhagen is to become a carbon-neutral world city by 2025, we have examined the steps that the city government is taking to bring it closer to that goal as effectively as possible.

To develop the objectives of an article, we draw on available official publications, scientific journals from the Web of Science, Science Direct, Scopus, Springer, Tailor and Frances databases and official statistics published through Eurostat's online libraries, World Bank Database and official documents published by European Commission and United Nations.

3 The essence of sustainable urban development

Urban sustainability is the idea that a city can be systematically organized without over-reliance on adjacent larger cities. The aim is to build a quality urban environment, to create the smallest possible ecological footprint through the efficient use of natural resources, the production of the least possible emissions, the efficient use of land and the recycling of used materials. Sustainability is also about improving livelihoods through social facilities, economic opportunities and health to better suit the capacities of local, regional and global ecosystems.[1]

A sustainable city is an area where there is minimal damage to the environment, the economic base is stable, resources are fairly distributed and working opportunities are secured. It is a city in which there is a strong sense of community and local people are involved in deciding on various issues and problems. Sustainable urban life includes several initiatives, including the use of renewable technologies, energy efficiency, the use of public transport, accessible resources and services. Other important urban sustainability initiatives include: improving the quality of life in the city, including

economic, environmental, cultural, political, institutional and social activities, without burdening future generations. [2]

As part of environmental activity, it is very important for cities to reduce the consumption of natural resources and traces of waste production and to improve land use efficiency so as to minimize negative impacts on the environment. The main representatives of urban structures must consider how to get resources into the city - how far away are the farms producing the basic products they supply to the city, what mode of transport is used to transport materials, how to pump water to the city.[3] The aim of promoting a healthy urban environment in general is to promote the minimization of the burden on the environment, through an efficient and well-developed public transport network, to reduce the need to use cars, to protect biodiversity and to bring nature to all citizens. [4]

Nowadays, modern urban development has an increasing tendency towards a sustainable city model. Residents are showing increasing interest in a healthy environment, affordable services, the possibility of cycling and quality urban public transport. Above all, residents should feel comfortable, safe and have all services easily accessible. The city should provide a healthy living environment in which residents have the opportunity to create strong social communities that are a natural part of their lives. It should be noted that the behavior and lifestyle of the population also play a very important role. [5]

The aim of the article is to explain the concept of a sustainable smart city with a connection to transport and mobility within case study of green European city-Copenhagen which is generally recognized as a leader in the global green economy.

3.1 Smart and sustainable cities

Smart cities are areas where resources are used intelligently and efficiently. They use innovative technologies to save costs and energy, enrich the services offered by the city and especially to increase the quality of life. [6] The main initiative of smart cities is to support economic growth and improve the quality of life of the population through the use of technology. The implementation of intelligent solutions allows cities to use technology, information and data to improve infrastructure and services. Comprehensive development in this way improves the quality of life, creates jobs and increases the incomes of the population. [7]

The basic elements of infrastructure in a smart city include: quality sources of water supply, secured supply of electricity, sewerage, including solid waste management, sustainable environment, citizen safety, health and accessibility of education, efficient urban mobility and public transport, accessible IT connection and digitization, adequate governance, building e-government and citizen participation.

Smart cities strive to be innovative and to bring ready-made solutions in various areas of urban systems. They offer mobile and network services that improve the quality of life of the population. Among the most important aspects that the smart city model focuses on are: mobility, economy, housing, urban management and a sustainable environment. The basis of most of the listed aspects is their interconnection and the

ability to generate data that is intelligently used to ensure optimal use of resources and improve their performance. [8]

The concept of smart and sustainable cities can play an important role in improving cities' carbon footprint by moving to smarter energy use. Through the implementation of innovative technologies, they enable more favorable use of energy in construction, transport, street lighting, etc. They can also facilitate the integration of locally produced renewable energy into the electricity grid. The use of intelligent technologies has a positive impact on the operation of the urban system infrastructure in the construction of intelligent buildings, transport systems, schools, businesses, public services and spaces and other integrations of intelligent urban systems. [9]

This integration serves socio-economic and environmental development, improves the quality of life and addresses the origins of social instability in cities. Digital infrastructure can help integrate different urban infrastructure systems, including energy, water, sewerage or transport, and enable these systems to be effectively managed, controlled and optimized throughout the city. These initiatives also address environmental issues and the availability of human resources. [10]

4 Implementation of strategic goals of sustainable urban development on a concrete example: Case study of Copenhagen

The Copenhagen region accounts for almost 40% of Denmark's production, ensuring stable long-term economic growth. At national level, Denmark's gross domestic product per capita is ranked among the top 10 countries in the world. At the same time, the city has grown while improving its environmental performance and transitioning to a low-carbon economy. [11]

Copenhagen is known as an environmentally friendly city, thanks to effective urban planning, support from national legislation and the involvement of local people in urban planning decisions. It is one of the few cities that excel in its long-term efforts to develop urban sustainability. It is an innovative city, surrounded by water areas with many parks and green areas. An integrated network of public transport and cycling routes provides residents with a variety of types of ecological mobility. [12]

Copenhagen is widely known for its ambition to become a "green, smart and carbon neutral city" by 2025 - a unique ambition that makes the capital of Denmark a model for European cities. Since the UN Conference on Climate Action in Copenhagen, the city has focused its efforts on mitigating climate change. One of Copenhagen's first climate plans aimed for carbon emissions of at least 20% between 2005 and 2015. This goal will be achieved as early as 2011, as a result of which a new climate plan was adopted in 2012. The new ambitious climate plan has the ambition by 2025 to make Copenhagen the first carbon-limited capital in the world.

As part of its ambition for sustainable development, Copenhagen strongly supports the Danish government and its environmental policies. The "Copenhagen model of urban development" refers to a unique vision of urban life combining environmental initiatives, economic growth and quality of life. [13]

4.1 A green, smart and carbon neutral city

In the face of rising rainfall, rising sea levels and rising temperatures in the city center, Copenhagen has developed its own climate change adaptation plan as part of the city's overall climate plan (CPH 2025 Climate Plan). Copenhagen has integrated adaptation to climate change into all aspects of planning, from overall spatial planning to local and sectoral plans. Since the UN Climate Change Conference in Copenhagen, the city has focused its efforts on mitigating climate change. [14]

According to statistics obtained from the gradually achieved goals of the Copenhagen Climate Program 2025, "in the meantime, the city has managed to reduce its impact on the environment by reducing CO2 emissions by more than 20% over 10 years. It has also been possible to ensure that 30% of energy supply comes from carbon-neutral sources. Although these ambitions are aimed at mitigating climate change, Copenhagen must still adapt to the necessary changes in future weather conditions. [15]

Although these ambitions are aimed at mitigating climate change, Copenhagen must still adapt to the necessary changes in future weather conditions. Precipitation in Copenhagen is expected to increase by 30 to 40% by 2100 compared to the current situation, while water levels around the city are likely to increase by 33 to 61 cm over the next decade. "At the same time, the climate plan ensures that measures are taken in the most efficient and effective way. The city is trying to take proactive steps to improve flood protection against rising water levels. [16]

One and not the last aim of ambitious Copenhagen´s climate plan is to reduce transport emissions by 135,000 tons by 2050. The sector accounts for around 22% of CO2 emissions, which is low given the large city and also the result of the city's previous efforts in this area. More than half of Copenhagen's population says that bicycles are their main means of transport. The ratio of ownership of bicycles to cars is 5: 1, 36% of all trips to work and for education is carried out through bicycle transport. The aim of the climate plan is to increase this value to 50% by 2050, while ensuring that 75% of all roads in Copenhagen are by cycling, walking or public transport. The city also aims to increase the use of public transport by 20% and ensure its carbon neutrality. [16]

Other targets are set for 20 to 30% of all light vehicles and 30 to 40% of all heavy vehicles to run on alternative fuels such as electricity, hydrogen or biogas by 2025. To achieve these goals, Copenhagen is expanding and improving its cycling and public transport infrastructure in various ways, including "green wave" traffic signs favoring cyclists and public transport and rest areas for cyclists at crossroads. [17]

In collaboration with neighboring communities, Copenhagen has begun construction of "bicycle highways" that are wider, smoother and better lit. Some sections consist of three lanes, in order to encourage the inhabitants of suburban areas to travel to the city center by bicycle instead of by car. A total of 26 motorway bicycles were planned for 300 km. [18]

The climate plan was developed in close cooperation with businesses, Copenhagen citizens, NGOs and professional institutions. Due to the necessary revision, new

developments at national and EU level were taken into account in 2016. Local residents are actively involved in implementing the Climate Plan through the use of cycling mobility, sorting household waste, installing solar panels and introducing an energy-efficient lifestyle. With the right approach of the people of Copenhagen to the protection of the environment, they create added value in improving their surroundings. At the same time, there is a benefit in the form of savings on energy consumption, with residents saving more than DKK 4,000 (EUR 536) per year. The climate plan will have a positive economic impact, as energy savings will offset any increased costs of producing and transporting energy. It will benefit both businesses and households: a couple with one child living in an apartment, with one car, could save DKK 6500 (EUR 872) a year. [19]

4.2 Ways of using urban mobility

In terms of urban mobility, Copenhagen is clearly a successful example of managing and using urban mobility. As a result, the Danish capital is considered the "European Capital of Cycling". Despite an ever-growing population, approximately 1,000 inhabitants per month, the city is successfully in optimizing the use of car mobility. [20]

As we have discussed in the previous section, one of the main objectives of the Copenhagen Urban Development Plan is to make the mobility of the population through the use of bicycle transport exceed the use of car mobility. According to the statistics of the World Economic Forum 2018, there were 675,000 bicycles and only 120,000 cars in Copenhagen, which means that the ratio of the number of bicycles to cars exceeds the discussed ratio of 5: 1. Almost 29% of the mobility of people around the city is realized by bicycle, while commuting to work and education represents a value of 41%. In 2016, Copenhagen cyclists drove a total of 1.4 million km every day. This is an increase of 22% since 2006. [21] One of the main reasons for the popularity of cycling in Denmark is the quality network of cycle paths, including the innovative bridges that make up the cycling highways throughout the city. This may be the key to understanding why Copenhagen is also one of the safest places for cyclists. Between 2006 and 2016, cyclists' sense of security increased from 53% to 76%. The city council has the ambition to achieve security up to 90%. [23]

Norrebrogade, the cycle path and also the main radial street from the suburbs to the city center represent an important connection for cyclists to the city center as well as to the surrounding areas. It is also a central shopping district in a densely populated modern area. It used to be an ordinary city district, where you could drive at a maximum speed of 50 km / h. In both directions there were two lanes for cars and one bike path in places as narrow as a sidewalk with a width of two meters. In both directions there were two lanes for cars and one bike path in places as narrow as a sidewalk with a width of two meters. Approximately 40,000 cyclists travel along its route daily. [22]

To increase the speed of travel for cyclists, a "green wave" for cyclists was set up in Norrebrogad in 2006. In most cases, green waves are planned to promote smooth car traffic. In Copenhagen, this principle was changed to promote smooth cycling. Green waves were introduced in the three streets of Norrebrogade, Osterbrogade and Farimagsgade.

Nowadays, a total of approximately 1,000 km of cycle paths are available in the city area. Of this, only 200 km are high-speed cycle routes (so-called Cykelsuperstier), which are developed and designed to motivate residents to prefer cycling. These bike paths are three meters wide and the traffic lights along them are synchronized to create a green wave and ensure that cyclists do not have to stand at intersections. The main motivation of the population to use bicycle transport is the fact that it is faster, more comfortable, cheap and healthy. However, cycling has an obvious environmental effect, which reduces CO2 emissions, air pollution and noise reduction. [23]

The development of sustainable urban mobility in Copenhagen also aims to raise awareness of pedestrian mobility. The aim of the Copenhagen Pedestrian Strategy is to encourage the population to promote pedestrian mobility. There are many good reasons for this: pedestrians help to create a livelier and more diverse city that is safer for everyone, encourages residents to engage in daily activities, induces mental and physical well-being, provides space for socialization and, among other things, is environmentally friendly. [24]

In 2008, Copenhagen signed the International Walking Charter, with the aim of creating healthy, efficient and sustainable communities that support walking within the city. Since the signing of the charter, the city has developed a strategy in close cooperation with the residents themselves, who are actively involved in the design of new walking routes and shortcuts. The city focuses on four main priorities: developing a culture of walking, creating pedestrian paths and meeting spaces, and increasing the attractiveness of shopping streets and transport hubs such as stations and bus stops for pedestrians. The aim is to provide pedestrians with safer conditions with clean sidewalks and public spaces where people can enjoy the street urban atmosphere. [25]

An integrated public transport network is successfully developing in Copenhagen. Local trains, the metro and the high-frequency bus network form the basis of Copenhagen's public transport system. A sign of the expansion of integrated public transport in Copenhagen is the expansion of the city ring road network - "Cityringen". Its construction began in 2011 with a planned completion by 2019. The new circuit is expected to carry around 234,000 passengers on weekdays, add 3,000 new routes in the wider Copenhagen area and about 3.4% more routes via public transport. The aim of the construction is to increase the quality of the infrastructure and help to develop the city center. Simultaneously with the construction of the new metro circuit, the rest of the public transport infrastructure is being modified in order to ensure the best possible interaction between other modes of transport - bus, bicycle and rail transport.

In addition, the city is improving the availability of buses on sections of the central road. Special lanes are being set up for buses, stops are being provided for the high-frequency bus network, shelters and real-time information on bus arrivals are being improved. In addition to physical initiatives to develop integrated public transport, the city also works to influence traffic habits through campaigns, brand building and information provision. The city is especially focused on the above-discussed bicycle traffic, where the "I bike CPH" brand dominates. The last cycling campaign was to spread "good cycling karma" by distributing chocolate. The city is constantly working on new transport plans for all spheres, in order to encourage residents to change their transport habits. [26]

In Copenhagen, trains and the metro are considered to be the lowest CO2 emitting modes of public transport. Their CO2 emissions per passenger km are less than half that of buses. The number of passengers by public transport is approx. 750,000 passengers per working day and just under half will be transported by train and metro. The city is constantly working to reduce traffic collisions, for example by introducing congestion charges. This step would help reduce car traffic in the city. The city has also changed and expanded its parking strategy to reduce suburban traffic in particular. [27]

The areas of paid parking spaces are increasing and with them the prices for parking. Among other things, the 2009 urban planning introduced a set of parking standards to ensure that Copenhageners can park their cars close to their homes and thus limit car mobility. In addition, the city seeks to promote the use of car-sharing systems and the availability of reserved parking spaces for licensed vehicles. Finally, as part of the city's road network plan, the city has adopted the principle that car mobility should primarily take place on main roads and that roads should be designed to suit their function. For example, the roads of the main street of the city center, Norrebrogade, are proposed to be left without traffic and to improve conditions for pedestrians and cyclists.

As part of the city's initiative to ensure the environmentally friendly use of fuels, the city provides laboratory testing for hydrogen and biofuels. By 2015, 85% of city passenger cars were to be powered by electricity or hydrogen. By 2025, the goal is for 20-30% of all passenger cars in the city to be powered by hydrogen, electricity or biofuels, with five hydrogen filling stations in the Greater Copenhagen area. Greater use of fuel cell electric vehicles (FCEVs) will bring a number of benefits, including better air quality, reduced noise and the absorption of excess wind energy. FCEV fuel cells will be integrated into a car association system with training to help users handle vehicles. [28]

Overall, developments over the last 10 years have gone in the right direction. The ratio of bicycle and public transport to car transport has increased, although the population is growing and more jobs are being created. For many years, the city of Copenhagen has sought to improve conditions for cyclists in the city and to encourage residents to make cycling a priority for mobility within the city. And that is exactly what they managed to achieve. Since 1998, the number of kilometers traveled by bicycle has increased by approximately 30% and this value is constantly increasing. An effective tool to support political decisions were the so-called Cycling and Traffic Accounts under the common name "Green Accounts", which assess the city's initiatives, the achievement of goals and the views of the city's residents. Through these acts, the direction the city is taking is very clear. Especially if we evaluate whether the initiatives are working according to plan. Competent politicians and officials can use this to tailor and develop future initiatives.

For example, Cycling Accounts clearly show the importance of effective campaigns, visible signage and other more communicative initiatives following physical changes in urban areas. The most effective impact of the achieved changes occurs only when the physical and visual side complemented by the campaigns has effective effectiveness. [29]

5 Conclusion

Cities are strategic areas in a global context in terms of economic wealth and innovation, but they are also places where social and environmental pressures are intensifying. The urban planning system is an expression of how local governments can regulate the link between the objectives of economic development, the environment and the quality of the urban environment.

The diversity of planning systems and practices is the result of the historical and geographical development of specific cities and the way in which they are linked to national institutional structures, culture and economic opportunities. However, the way in which economic development, the quality of the environment and the quality of life are linked to local strategies is important for the overall economy and environment.

References

1. VERMA, Pramit– SINGH, Pardeep– SINGH, Rishikesh– RAGHUBANSHI, A.S. Urban Ecology– Emerging Patterns and Social-Ecological Systems. 532 pp. Amsterdam: Elseviser, 2020.
2. GEF Secretariat, Sustainable Cities Program. 4 pp. World Bank, November 2017.
3. JAMES, Paul et al. Urban sustainability in Theory and Practice- Circles of Sustainability. 282 pp. New York and London: Routledge 2015.
4. European Commision. Science for Environmental Policy. IN-DEPTH REPORT: Indicators for Sustainable Cities. 24 pp. Vol. 12, European Union, November 2015
5. MACDONALD, John– BARANAS, Charles– STOKES, Robert. Changing Places: The Science and Art of Urban Planning. 208 pp. Princeton University press, 2019.
6. NAYDENOV, Kliment. Smart Citie– The Future of Urban Planning. Bulgaria: Sofia University "St. Kliment Ohridski", 7 pp. 2018.
7. BACULÁKOVÁ, Kristína. Selected Aspect of Smart City Concepts. Theoretical and Empirical Research in Urban Management. Vol. 15, No. 3. 68- 80 pp. Research Center in Public Administration and Public Services, August 2020.
8. BARLOW, Mike– LEVY BENCHETON, Cornelia. Smart Cities, Smart Future: Showcasing Tomorrow. 336 pp. John Wiley & Sons, 2018.
9. NAYDENOV, Kliment. Smart Citie– The Future of Urban Planning. Bulgaria: Sofia University "St. Kliment Ohridski", 7 pp. 2018.
10. European Commision DG INFSO. Final Report– Impact of ICT on Energy Efficiency. 410 pp. September, 2018.
11. Green Growth Knowledge Platform. Copenhagen: green economy leader report. London School of Economics and Political Science, december 2014.
12. World Wildlife Fund. Copenhagen climate plan. First carbon neutral capital by 2025. WWF,https://wwf.panda.org/?229197/Copenhagen-climate-plan, last accessed 2014/09/18
13. Field Actions Science Reports. Copenhagen: resilience and liveability. Issue 18. https://journals.openedition.org/factsreports/4750, last accessed 2018/12/15
14. European Commission. Copenhagen Plans Adaptation For Climate Change, https://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/denmark/480_en, last accessed 2010/03/09
15. BOSWELL, Michael R.- GREVE, Adrienne I.- SEALE, Tammy L. Climate Action Planning: A Guide to Creating Low-Carbon, Resilient Communities. Island Press, 2019.

16. The Technical and Environmental Administration. CPH 2025 Climate Plan- English: A Green, Smart and Carbon Neutral City. The City of Copenhagen Technical and Environmental Administration, 2012.
17. HENDERSON, Jason- GULSRUD, Natalie Marie. Streets Fights in Copenhagen: Bicycle and Car Politics in a Green Mobility City. Advanced in Urban Sustainability. 202 p. Routledge, 2019
18. WWF. Copenhagen climate plan: First carbon neutral capital by 2025. WWF 2014, https://wwf.panda.org/?229197/Copenhagen-climate-plan, last accessed 2014/09/18
19. PEDERSEN, Peder Vejsig- KLINT, Jakob- KAPPEL, Karin- PEDERSEN VEJSIG, Katarine. Green Solar Cities. 316 p. Routledge, 2015.
20. COLVILLE- ANDERSEN, Mikael. Copenhagenize: The Definitive Guide to Global Bicycle Urbanism. 275 pp. Island Press, 2018.
21. FLEMING, Sean. What makes Copenhagen the world´s most bike-friendly city? World Economic Forum. https://www.weforum.org/agenda/2018/10/what-makes-copenhagen-the-worlds-most-bike-friendly-city/, last accessed 2018/10/5
22. International Charter for Walking. Creating healthy, efficient and sustainable communities where people choose to walk. 9 pp.WALK21 International conference series, October 2006.
23. State of Green. Sustainable Urban Transportation: Creating green liveable cities. 13 pp. State of Green, 2016.
24. State of Green. Copenhagen: Solutions for Sustainable Cities.3rd edition. 56 pp. City of Copenhagen, January 2014.
25. OECD. OECD Territorial Reviews: Copenhagen, Denmark 2009.Volume 2009. 292 pp. OECD Publishing, 2009.
26. NIKEL, David. Copenhagen Aims To Be World´s First Carbon Neutral Capital by 2025. Forbes, https://www.forbes.com/sites/davidnikel/2019/08/22/copenhagen-aims-to-be-worlds-first-carbon-neutral-capital-by-2025/, last accessed 2019/08/2019
27. ClimateActtion. Climate Plan 2025 in Copenhagen, Denmark. Copenhagen, https://www.climateaction.org/news/copenhagen_denmark_aims_to_be_carbon_neutral_by_2025/, last accessed 2013/04/15