

Green Mobility as an Approach for Sustainable Urban Planning

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ABSTRACT: The issue of sustainable mobility in rapidly growing cities is now beginning to take center stage as a major obstacle to sustainable economic development. Rapid urbanization has led to levels of congestion and pollution that severely impair the economic prospects of cities and the health and wellbeing of the people that live in them. In addition, transportation is a major contributor to global climate change, particularly greenhouse gas emissions, meaning that it is the prime target for reducing air pollution and obtaining a sustainable environment. Therefore, urban planners worldwide continually attempt to support sustainable transport, especially in developing countries. Therefore, this paper focuses on green mobility, as it is considered to be an important approach to sustainable urban planning. In this context, the research aims to illustrate the role of green mobility via the study of an international example that applies the concept of green mobility, and then uses this to suggest a framework to develop the transportation system in Egypt.

KEYWORDS: Green mobility, sustainable urban planning, cycling, walking, Urban Design.

I. INTRODUCTION

Road congestion, urban sprawl, and air pollution are among the most important challenges facing cities today; indeed, green objectives have been introduced in the majority of cities. Green mobility is the main key sector for green economic growth. This paper will provide an overview of green mobility through a focus on international case studies that have applied this concept to their urban environment. A framework that integrates the concept of green mobility into the transportation infrastructure is highlighted, after which recommendations for the Egyptian context, to make its transportation systems more sustainable, efficient, and safe, are offered.

II. RELATED WORK

A steadily growing number of cities around the world are eager to become cities of bicycles, as part of an overall strategy on sustainable development and the desire to become green cities. Kielgast (2015) claimed in his study plan for Copenhagen that The development of cycle path networks that can supplement the public transport system also makes a significant contribution to reducing CO₂ emissions – in Copenhagen for example, cyclists are saving the city 90,000 tons of CO₂ emissions annually. It is also important to create a quality of urban environment that makes it attractive to move around both on foot and by bicycle. This is a self-perpetuating process since the presence of pedestrians and cyclists significantly contributes to the life of the city and thereby its attraction.[1]

City of Vancouver (2012) in its development plan for Transportation 2040 claimed that by 2040, at least two-thirds of all trips will be made on foot, bike, or transit. The total number of trips by sustainable modes will grow significantly, while motor vehicle volumes will slightly decline. It claimed also that this plan is about more than just mobility. The transportation vision and goals embrace the goals of this plan align with the transportation-related goals found in the City's Greenest City 2020 Action Plan: Make the majority of trips on foot, bike, and transit; eliminate dependence on fossil fuels; and breathe the cleanest air of any major city in the world.[2]

Freiburg city (2015) as another example defined in its approach for sustainability the important of establishing green mobility policies and standards. According this vision, a sustainable urban and transport policy, as well as an effective climate protection and environ-mental policy, are founded on a number of cornerstones including attractive and

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sustainable transport provision, therefore Freiburg’s transport policy, which has attracted attention nationwide, promotes environmentally-friendly modes of travel including walking and cycling, local public transport.[3]

III. THE RESEARCH PROBLEM

Transportation is now the fastest-growing source of greenhouse gases, accounting for 24% of global emissions, “Over 23% of greenhouse gas emissions worldwide come from the transportation sector”. Over half of the world’s population lives in cities, and this number is only increasing. However, while most of the world’s wealth is created by urban residents, they are also responsible for approximately 75% of its CO2 emissions. Reducing such emissions is just a small part of being a sustainable city, and local government policies and workplace practices should reflect the urgent need to increase the use of sustainable modes of transport. This paper poses three principal questions:

- How can we become more efficient at identifying and implementing green mobility solutions?
- How can green mobility contribute to the achievement of sustainable development?
- How can green mobility affect urban planning?

IV. RESEARCH METHODOLOGY

This paper explores the concept of green mobility from theoretical, analytical, and practical viewpoints; the desired endpoint is sustainability. As figure 1 shows, it seeks to identify the basic features of green mobility strategy, after which it analyses the way in which the concept of the “Copenhagen city” was developed. Finally, in practical terms, it suggests a set of recommendations to develop the urban transportation system of 6 October city, Egypt.

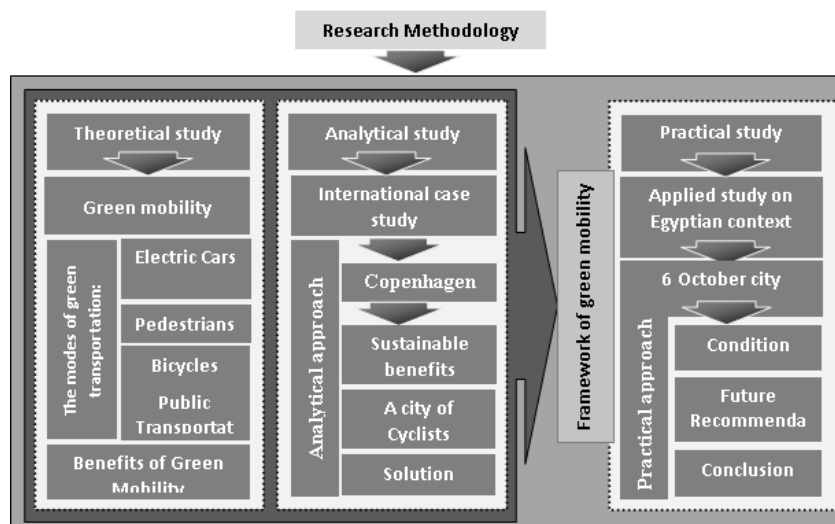


Fig. 1. Research Methodology.

V. RESEARCH OBJECTIVES AND HYPOTHESIS

The principal objective is to integrate urban development policies that support sustainable transport by applying the concept of green mobility. This study also aims to promote the use of the transport modes that are associated with the least pollution. That could be achieved by the following:

- Promoting energy efficiency by advancing sustainable transport in urban areas;
- Being affordable, operating efficiently, and offering a choice of transport modes;
- Maintaining the integrity of ecosystems and minimizing land use and noise;
- Reducing noise, air pollution, and CO2 emissions;and

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- Creating a “greener” image for the city.

Therefore, this paper assumes that cities can achieve sustainable urban planning processes by applying the concept of green mobility.

VI. GREEN MOBILITY AS AN APPROACH TO SUSTAINABLE URBAN PLANNING

Definition of Green Mobility:

“Green mobility is sustainable transportation that allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and eco-system health, and with equity within and between generations. Green mobility is affordable, operating efficiently, offering choice of transport mode, and supporting a vibrant economy” [4]. “It limits emissions and waste within the planet’s ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land and the production of noise.”[4] Green mobility would be sustainable transportation. The word “sustainable” clearly means activities that support the long-term livelihood of our society. Green mobility addresses some of the problems we face with the existing transportation system. [5] For example, issues as Global Warming, Environmental Damage, Health impacts (physical health, emotional health, mental health, spiritual health), and Noise Pollution, using and disposing of transportation machines greenhouse gas increases are massively impacted by transportation.

The Modes of Green Transportation:

- a) Electric Cars: “Electric cars have long been touted as a greener alternative to the traditional internal combustion engine. Electric vehicles don’t just yield important environmental benefits associated with lower emissions, they also have performance benefits as they require less maintenance and provide quiet, smooth operation, and strong acceleration [6]. One of the major challenges to paving the road for electric vehicles is setting up the necessary infrastructure for battery charging [6].
- b) Pedestrians: “One should prefer to walk to the school, to work and to grocery shopping etc. Walking involves zero emission of any greenhouse gas, it’s free and it’s a good form of exercise for the body” [7].
- c) Bicycles: “Using bicycle to commute is another great mode of green transportation. Faster than walking, low cost and a healthy exercise. Buying and maintenance cost is only fraction of that required for car” [7].
- d) Public Transportation: “Most of the big cities have good infrastructure for public transport system. An affordable and easily accessible mode of green transportation, it is particularly useful for students and senior citizens who can get attractive discounts” [7].

The Benefits of Green Mobility:

Green mobility has wide-ranging benefits at environmental, health, economic, and individual levels. There follows a list of some of the key benefits of using green transportation: [7]

- a) A Less Polluted Environment: Since CO₂ emissions from fossil fuel burning in vehicles are the major cause of increasing levels of greenhouse gases, choosing green transportation modes will help reducing such emissions.
- b) Improved Health: Numerous activities associated with green transportation will lead to a healthier lifestyle. Walking and riding bicycles provide good exercise; reduced pollution will reduce adverse effects on the respiratory system, and less traffic means time and energy savings, and improved road safety.
- c) More Sustainable Economic Development: The manufacture of green vehicles and the expansion and improvement of the public transport system will create more job opportunities, thus reducing socio-economic inequalities and building more sustainable economies.
- d) Money Saving: Using green modes of transportation results in less fuel consumption, meaning that a lot of money can be saved annually.

VII. THE COPENHAGEN CASE STUDY

“Copenhagen is the World’s Best City for Cyclists. Especially important for transport is the objective saying 50 % of all people going to work or education in Copenhagen will go by bike.[8] The key efforts of the plans for transport are;

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the city of cyclists, improved public transport, traffic calming and parking restrictions, environmental efforts like low emission zones, possible congestion charging and environmentally friendly vehicles” [9].

The City of Cyclists:

The city of Copenhagen has set itself the overall goal of being the world’s best city for cyclists, and in 2007 it established a framework for measures in cycling. The goal is for 50% of people to be cycling to their place of work or education in 2015 (in 2010, this figure stood at 35%), thereby contributing to meeting the target of CO2 neutrality by 2025. Since 2006, over €67 million have been spent on cycling to implement a large number of initiatives, for example, two pedestrian/cycle bridges over waterways and major road arteries.[5]

Improved Public Transport:

Local S-trains, the Metro, and the high-frequency A-bus network are the foundation of the public transport system in Copenhagen. A city ring for the Metro is under construction and is expected to open in 2018.

Environmental Efforts:

“In Copenhagen, urban planners have embraced the widespread bicycle culture with ambitious solutions that accommodate the city’s many cyclists. This has inspired urban planners all over the world to ‘Copenhagenise’ their cities, making them more bicycle-friendly. Besides providing a more livable city, reduced carbon emissions and air pollution in the city, the shift from cars to bicycles also saves time and money. Looking at the total cost of air pollution, accidents, traffic congestion, noise and wear and tear on infrastructure when travelling by bicycle and car, society actually benefits by € 0.16 for every extra kilometer travelled by bicycle instead of by car” [5].“The goal is to create a network of bicycle lanes throughout Copenhagen. This will reduce traveling time and increase safety for their cyclists. Safety, convenience, comfort, timesaving and livability are the keywords in designing a city where cycling is the norm” [5].“Copenhagen has over 390 kilometers of bike lanes and is widely regarded as the bike capital of the world. Cyclists in Copenhagen are saving the city 90,000 tons of CO2 emissions annually. Every day, about 789,000 miles are bicycled in Copenhagen. Thirty-six percent of the city’s residents bike to school or work. The city is looking to increase that number to 50% by building more bike lanes, widening existing lanes, creating biking-only bridges over the city’s waterways, providing more space for parking bikes, and improving safety along existing bike routes”[6] (see Figures 2 and 3).“The city of Copenhagen clearly understands the value of biking-friendly cities. They are healthier, more environmentally-friendly, and allow for better quality of life” [6].

Solution in Detail:

The goal is to create a network of bicycle lanes throughout Copenhagen. This will reduce traveling time and increase safety for the city’s cyclists. Safety, convenience, comfort, timesaving, and livability are the keywords in designing a city in which cycling is the norm. More, and broader, bicycle lanes, improved design of intersections and behavioral campaigns are the means of achieving a safer city for cyclists. Using these types of initiatives, Copenhagen wishes to achieve a rise in the proportion of inhabitants feeling safe while cycling (from 67% in 2010 to 80% in 2015 and further to 90% in 2025).Figure 2 for example shows the change in using deferent types of transportation methodsin Copenhagen 2007-2010. It reflect the increased of the people directed to use green methods.

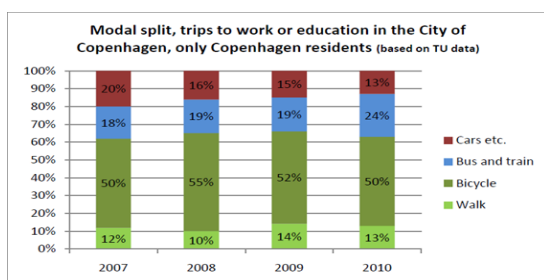


Fig. 2. Copenhagen is the city of cyclists. [9], [13]

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Figure 3 shows one of the streets prototype designs used in Copenhagen. It reflects the important given to cyclists by assigning the needed spaces in the street design process even in designing bridges.



Fig. 3. Designing Copenhagen for cyclists. [5], [10]

Cycling as an Important Mode of Sustainable Mobility:

In terms of sustainable mobility, urban planners have designed Copenhagen to make cycling particularly attractive with regard to environmental, social, and economic effects, namely (see Figure 4): [5], [6],[8], [11]

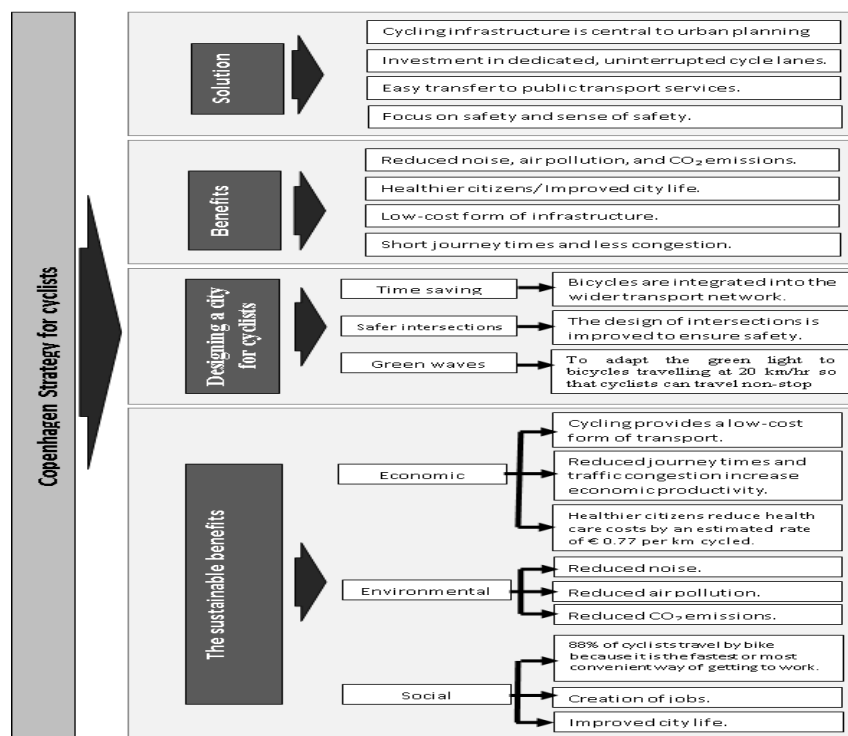


Fig. 4. Copenhagen Strategy for cyclists.

- Reduction in Traffic Congestion: In 2010, 35% of all journeys to places of work or education in the city were made by bike (for people working and living in Copenhagen, the numbers are even higher, reaching 50%).
- Time and Money Saving: Copenhagen saves €0.06 for every kilometre travelled by bike instead of by car (1.2 million kilometres cycled/day); the saved costs are estimated at € 14 million; the infrastructure is also less beset by car use. Fewer car accidents also contribute to total avoided external costs of € 31 million.

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- c) Quality of Life: It has been shown that half an hour of daily cycling increases mean life expectancy by 1-2 years; the health benefits of cycling also include fewer sick days, as well as fewer medical expenses and treatments, with the total health benefit estimated at €268 million per year.
- d) Small Local businesses and New Local Jobs: Today, “309 businesses that sell and repair bicycles are registered in the Copenhagen region, and these have generated 650 full-time jobs and a total estimated annual turnover of €174 million. In addition, are other firms, such as bicycle rental firms, pedicabs, bike messengers, as well as firms whose employees cycle during working hours (i.e. postmen), and an increasing number of firms purchasing staff bicycles for use on the job”[8].

In conclusion, Copenhagen depends on two strategies that are currently under political adoption:

- The Pedestrian Strategy encourages more people to walk more. “This will contribute to a living city, and a good urban environment” [9]. The goal is that pedestrian traffic will have increased by 20% in 2015 compared to 2009.
- The Cycle Strategy ensures that Copenhagen is the world’s best cycle city. A number of goals and initiatives have been drawn up to be implemented in the years up to 2025. These are to ensure that it is even safer, quicker, and easier to cycle than it is today, and that the goal that 50% of people will cycle to and from places of work/education in Copenhagen can be achieved (the percentage includes both those commuting into the city and Copenhageners themselves).

VIII. FRAMEWORK - TOWARD GREEN MOBILITY:

This section suggests a framework that depends on the previous study and it will contribute to meeting green mobility, as follows (Fig. 5). Figure 5 shows the main items that should be taken in account with reference to the previous analysis. It consists of two main categories including transportation methods and technology used.

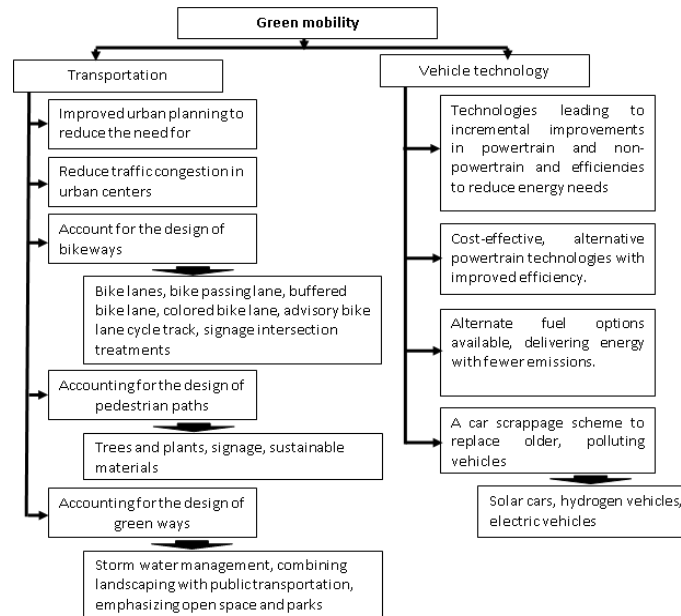


Fig. 5. A framework - towards green mobility.

IX. CASE STUDY OF 6 OCTOBER CITY, EGYPT

This section will deal with “6 October City” to document the most important problems facing urban transportation. There will then follow a suggested set of future recommendations, based on the sustainability framework, which has

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been created according to the results of the study, to develop the transportation system in “6 October City” in order to move toward green mobility.

The main objective is to convert 6 October City into a city of cyclists and to improve public transport.

- a) Improving cyclist and pedestrian safety;
- b) Providing universal accessibility;
- c) Improving the quality and experience of cyclists and pedestrians;
- d) Promoting a culture of cycling and walking; and
- e) Furthering walking as a sustainable, convenient, and viable part of Cairo’s multi-modal transportation system.

Urban transportation conditions in 6 October City, Egypt:



The study will address one of the main streets in “6 October city”, which is “EmtadaAlmehwar” street, as it joins the city with 26 July axis and Elwahas Road. In addition, it is considered the main approach to the city from these two roads. Moreover, many universities, such as Misr University, Nile University and Cairo University, and Mall of Arabian Hybar Market, are located in this street, as well as numerous residential sectors.

The street is challenged by a variety of urban and environmental problems, a high density of population, due to rapid growth of urbanization, environmental pollution due to old vehicles, traffic congestion, especially in Johaina Square, which is located in the middle of this street, and unsustainable urban transportation. In addition, the urban planning lacks fittings and bicycle facilities that are suitable for the use of cyclists (see Table 1). All of these problems have an impact on the environment and CO2 emissions, as well as air and noise pollution. Particular initiatives should be planned to limit noise and air pollution, as follows:

Due to the lack of cycle paths, the planner and the urban designer should create a continuous cycling system. The bike lanes should be separated by a barrier, be it greenery, colors, or sidewalks. Moreover, facilities for cyclists should be added, such as signage, road lighting, and bicycle parking. In addition, sustainability considerations should be considered, for example, promotion of the establishment of solar roads to use the electricity produced by the road to power street lights and traffic systems.

Finally, the electric and hydrogen car project is very ambitious, which will have a large environmental impact in the long-term, due to the fact that it can prevent air and noise pollution (see Table 1). This table defines the main suggestions to improve “6 October City”.

Table 1. Future Recommendations for 6 October City to be a city of cyclists:

| Policies | The current situation | A proposed design strategy |
|--|---|--|
| <p>Creation of a continuous cycle system directly through a wide cycle track should be installed</p> |  <p>Johaina Square</p> |  <p>Ref.: Trucks and cyclists don't go together http://www.ttcparts.com/blogs/external/readmore.aspx?ID=15</p> |

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| <p>Design paths to allow safe bike crossings</p> |  <p>Lack of bike crossing lanes</p> |  <p>Ref.: Dutch cycle lanes, http://lcc.org.uk/pages/go-dutch-gallery</p> |
| <p>Separate Cycle Path; design cycle lanes all over the street.</p> |  <p>Lack of bike lanes</p> |  <p>Ref.: Standard Dutch turning lane/bike lane https://bicycledutch.wordpress.com/2011/04/07/state-of-the-art-bikeway-design-or-is-it/</p> |
| <p>Creation of a high-speed cycle route.</p> |  <p>Lack of high speed cycle route</p> |  <p>Ref.: https://bicycledutch.wordpress.com/2013/03/14/f35-high-speed-cycle-route-twente/</p> |
| <p>Solar Bike Lane, promote the establishment of solar roads, as the solar power from the road will be used for practical applications in street lighting, traffic systems, and electric cars.</p> |  <p>Lack of sustainable facilities for cycling routes</p> |  <p>Ref.: http://www.citylab.com/commute/2014/11/the-netherlands-gets-the-worlds-first-solar-powered-bike-lane/382480/</p> |
| <p>Signage should be considered to control road user behavior and directional signs.</p> |  <p>Lack of signage for cycling routes</p> |  <p>Signage for cyclists [10]</p> |

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|---|--|---|
| <p>Road Lighting should be applied to cycle tracks.</p> |  <p>Lack of sustainable facilities for cycling routes</p> |  <p>Lighting for cyclists [10]</p> |
| <p>Route Guidelines; The design should create awareness using messages to indicate the presence of both pedestrians and cyclists.</p> |  <p>Lack of sustainable facilities for cycling routes</p> |  <p>Guidelines for cyclists and pedestrians</p> |
| <p>Bicycle Parking; parking facilities should be located, such as solar parking lots where electric hybrid bicycles can be recharged from sunlight-powered panels.</p> |  <p>Lack of bicycle parking facilities</p> |  <p>Examples of innovative parking facilities</p> |
| <p>Solar e-bike; solar panels in the areas of the wheels. The panels absorb solar energy and charge the battery. The motor can push the bike at 25 to 50 kph.</p> |  <p>Lack of sustainable facilities for cycling routes Ref.: Gobike adventures in Cairo http://www.washwasha.org/64669</p> |  <p>Examples of solar e-bike http://www.psfk.com/2015/05/an-ebike-that-charges-directly-from-the-sun.html</p> |

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X. CONCLUSION

Green mobility is a way to achieve sustainable cities, and cities need efficient and affordable solutions to prevent traffic jams, improve urban environmental degradation, and reduce CO₂ emissions. Thus, this paper focused on the definition and benefits of the concept of green mobility via an analytical study of Copenhagen City, as this is a good international example in applying this concept. Copenhagen aims to be the most bicycle friendly city in the world. The goal is to integrate buses, metro, and S-trains, creating an efficient public transport system. Cyclists and pedestrians will also be integrated into this transport system, and the transport plans of Copenhagen are to reach carbon-neutrality in 2025.

The paper then developed a framework to move toward green mobility. Thus, to establish this concept in urban planning, a specific strategy should be considered. This includes transportation infrastructure and vehicle technology. Transportation infrastructure depends on the establishment of solar roads, which convert the sun's energy into electricity, creating a continuous cyclist system, reducing the need for mobility through improved urban planning and consideration of the design of pedestrian paths. Vehicle technology depends on the use of solar e-bikes and alternative fuel options to deliver energy with fewer emissions.

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BIOGRAPHY



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