### Research Progress in the Design Concept of Green Commuting Cities

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*Abstract:* The connection between green commuting and urban design was intimately intertwined in this study. As urbanization progressed, issues such as population growth, housing, transportation, and the environment had become increasingly salient. Green commuting had emerged as a vital strategy to mitigate these challenges and enhance the quality of life for urban residents. This paper elucidated the principles underlying green commuting, highlighting a human-centric approach, the interconnections between public transit, walking, and cycling as modes of travel, and the significance of the digital city paradigm. By examining the transportation systems and urban design methodologies, techniques, and characteristics of Vienna and Copenhagen, the paper delineated the strengths and weaknesses in the development of these cities. It delved into the design approaches and philosophies in green commuting from these two cities that were exemplary and worthy of emulation. The paper proposed potential strategies for green and low-carbon design in future urban transportation, aiming to construct a more ecologically sustainable urban transportation system and infuse new dynamism into urban development.

*Keywords:* Green Commuting, Urban Design, Transportation System, Sustainable Development.

#### 1. Introduction

As the global urbanization process continued, the population kept growing, urban spaces became increasingly congested, and the ownership of private vehicles persistently increased, urban traffic issues underwent a transformation. The city development model based on automobile traffic, which was popular in the last century, could no longer accommodate the increasingly severe problems of traffic congestion, environmental pollution, and energy consumption [1]. Therefore, constructing a green, sustainable, and efficient transportation system had become an important subject of urban development. Urban travel demanded not only diversification and efficiency of transportation modes but also consideration of green and low-carbon options alongside economic benefits.

The concept of green travel, introduced in the early 1990s, quickly gained public acceptance, yet its implementation and promotion still faced numerous constraints. Green travel referred to environmentally friendly modes of transportation, such as public transit systems, rail transit systems, cycling systems, and pedestrian systems, which were part of a low-carbon, green travel system [2]. The ultimate goal of the green travel philosophy was to achieve harmonious development between humans and nature, as well as between humans and society, in line with the concept of sustainable

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development. The realization of this philosophy depended on urban design that integrated spatial layout, functional zoning, and transportation planning. Through these means, cities could be organically planned and designed to coordinate and allocate resources rationally. Generally, green travel was reflected in various aspects of urban design concepts. Scholars such as Audrey de Nazelle conducted a literature review on policies that encouraged active travel, noting that while the comprehensive effects of these policies were not fully understood and were difficult to quantify, they did have a positive impact on health [3]. Research by Todor Stojanovski, Zhao Penglin, and Zhang Ning all emphasized the potential of Transit-Oriented Development (TOD) models in alleviating traffic congestion and reducing carbon emissions [4-5]. Barton, Hugh, and Marcus Grant analyzed responses to a comprehensive assessment questionnaire and identified the three most important Health Urban Planning (HUP) issues, concluding that health city initiatives had had a significant positive impact in advancing key planning policy areas, while also revealing the diverse challenges that cities prioritized in health urban planning [6]. Michael Southworth pointed out that walking not only reduced traffic congestion and environmental impact but also had social and recreational value and was beneficial to physical and mental health. Studies had shown that walking could promote psychological and physical well-being [7]. Nesti and Giorgia, through a case analysis of four European cities, explored the degree of transformation of smart city governance models, existing problems, and potential connections with the new public governance paradigm [8]. Their research provided valuable perspectives and insights for understanding the governance of smart cities.

Vienna and Copenhagen, recognized as international livable cities, had achieved notable success in the realms of green travel and urban design, with experiences that merited thorough investigation and emulation. This paper conducted an analysis of the characteristics and strengths of the green travel transportation systems in Vienna and Copenhagen, and proposed feasible recommendations for the implementation of green travel initiatives.

2. Urban Planning Cases for Green Travel

# 2.1. Austria's Vienna is characterized by its integrated planning of pedestrian and public transportation systems

Vienna, located in the northeastern part of Austria, was the most populous city in the country, accounting for approximately one-fifth of the national population. It served as Austria's economic hub with a developed industry and service sector. Vienna was a city with a long history, rich culture, and thriving economy. It was renowned worldwide for its unique geographical location, beautiful natural scenery, abundant historical and cultural heritage, and prosperous economy, making it a well-known livable city. In urban planning and design, Vienna adhered to the basic concept of sustainable development, always focusing on building walkable communities and creating vibrant public spaces [9]. In its planning, Vienna had implemented zoning, conducting detailed planning according to the current characteristics of different zones, and formed three typical models: a pedestrian-priority and traffic-calmed shared space model, a multi-level separated space model for pedestrians and vehicles.

# 2.2. Denmark's Copenhagen is distinguished by its comprehensive bicycle transportation system

Copenhagen, the capital of Denmark, was strategically located on the eastern part of Zealand, the main island of Denmark. It stood as the political, economic, cultural, and transportation nexus of the country, exuding charm in both its natural and anthropogenic landscapes. It was recognized by UN-Habitat as the "World's Most Livable City" and was lauded as the "Best Designed City." Copenhagen's urban planning was consistently aimed at achieving the status of the "world's first

carbon-neutral city." The city advanced its low-carbon development through the implementation of the "finger plan" approach to urban layout. Bicycling was a significant mode of transportation in Copenhagen, serving as a vital means for commuting and fulfilling various functions such as the delivery of goods, thus becoming an integral component of the city's daily traffic system. This status was a result of Copenhagen's continual focus on transformation and improvement of its transportation infrastructure.

#### 3. Characteristics and Pros and Cons of Green Travel Urban Planning

Green travel planning aimed to construct an environmentally friendly and efficient transportation system, characterized by two main features: First, there was a close coordination between walking and public transportation, which encouraged short-distance walking and reliance on efficient public transit for medium to long distances. This approach reduced the use of private vehicles, alleviated traffic congestion, and lowered carbon emissions. Second, it advocated for human-centered bicycle city construction, incorporating infrastructure that created a safe and comfortable cycling environment, enhancing the convenience of travel, invigorating urban vitality, and popularizing green travel.

#### 3.1. Integration of Walking and Public Transportation Modes: A Case Study of Vienna, Austria

Vienna focused on constructing pedestrian-friendly community spaces to improve the urban pedestrian traffic system and promote the construction of a low-carbon sustainable city [10]. The pedestrian path system was subject to the constraints of community space patterns; hence, Vienna undertook transformations with different emphases and methods according to the community space patterns of different zones. For instance, in the planning of the Neuburg district, the shared space model premised on pedestrian priority and traffic speed limits was emphasized. To ensure pedestrian priority, the district's planning reduced the behavior of motor vehicles continuously traversing urban blocks through a dense network of small-scale roads and restricted access controls. Moreover, the four boundary roads were connected to the urban road network and were planned as two-way traffic routes, attracting a larger volume of vehicle traffic. The internal roads of the district were mostly oneway and had a speed limit of 30km/h, which helped to reduce unnecessary vehicular traffic within the district. Some sections were only open to buses and taxis, with a speed limit of 20km/h, ensuring that the road space was neither too empty nor more suitable for walking. Activities such as walking, cycling, and stopping naturally had more space and opportunities to occur. The public transportation network in the Neuburg district also achieved full coverage, with subway and tram stations accessible within a 200m walking distance. At the same time, most transportation stations were equipped with public bicycle rental stops and public car sharing stops nearby.

The urban planning of Vienna in green travel brought significant positive impacts. Firstly, the environmental benefits were remarkable. The constraints on private car travel in Vienna encouraged citizens to more actively choose low-carbon travel methods such as walking, cycling, and public transportation, thereby effectively reducing carbon emissions in the transportation sector, improving urban air quality, and further positively contributing to the mitigation of the global warming trend. Secondly, it alleviated traffic congestion. The optimization design of the road network and traffic nodes improved Vienna's travel efficiency, reduced traffic congestion caused by an excess of private cars in the urban area, enhanced the fluency of urban traffic, and strengthened the convenience of citizens' travel.

However, the aforementioned planning had certain drawbacks during the preparatory stage and even after implementation. Firstly, there was considerable financial pressure. The construction of

bicycle parking stations and road networks, and the improvement of the public transportation system required substantial financial support, posing a significant challenge to the government's finances. For economically underdeveloped small towns, financial pressure was not negligible. Secondly, public acceptance and habits needed to change. Citizens' travel habits could not be changed in the short term simply due to policies and the construction of transportation systems, presenting some difficulties in implementation. Additionally, there were regional differences. Different regions varied in economic development levels, population density, and travel demands, and the implementation effects of green travel planning varied by region, necessitating attention to issues of equity between regions.

#### 3.2. Human-Centered Bicycle City Construction Model: A Case Study of Copenhagen, Denmark

Copenhagen consistently adhered to the people-oriented sustainable development theory and was committed to creating and maintaining a livable urban environment. The city's construction model was based on the "finger plan" concept [11], which divided the city into different areas according to economic, population, development planning, and geographical conditions. The central urban area, as the "palm," focused on improving the public transportation system. The periphery consisted of five "fingers," providing new spaces for urban expansion, with an emphasis on infrastructure development and public transportation services. The spaces between the fingers were called "green wedges," used for greening.

Copenhagen's bicycle system could be divided into exclusive bicycle lanes and roadside bicycle lanes. Exclusive bicycle lanes included a network that crossed overpasses, tunnels, railways, and rivers, establishing direct cycling routes between large residential areas in the suburbs and the city center. Management measures for bicycle lanes included elevation changes and coloring to distinguish them. At public transport intersections, there were dedicated bicycle traffic lights, and lanes were designated for left turns, right turns, and straight movements to regulate cycling. Relying solely on bicycles to complete the city's transportation was not feasible. What Copenhagen had developed was a typical Transit-Oriented Development (TOD) model. The TOD model was not only beneficial for maintaining the strength of the central urban area but also achieved connectivity between newly developed areas (the "fingers") and the central urban area.

Copenhagen's urban planning had become very mature and well-developed, achieving significant results. However, there were also certain challenges. First, the planning and implementation requirements were high. Copenhagen's comprehensive bicycle traffic system and public transportation system required feasible, long-term planning and had been realized through long-term transformation, requiring the city to have patience and keen insight for development. Second, the initial investment cost was high. Building a comprehensive pedestrian path, bicycle path, and public transportation network required substantial financial input, facing significant financial pressure and implementation difficulties. Additionally, there were issues with facility maintenance and safety management. The maintenance and safety management of facilities such as pedestrian paths and bicycle paths required the establishment of a sound management mechanism to ensure the safety and sustainability of the facilities.

#### 4. Green Urban Travel Optimization Strategies

The core of green urban travel optimization strategies lay in advocating and promoting low-carbon, environmentally friendly, and efficient modes of travel, such as walking, cycling, public transportation, and new energy vehicles. These modes of travel could not only significantly reduce carbon emissions and air pollution in the transportation sector but also effectively alleviate traffic

congestion and improve the operational efficiency of the urban transportation system. At the same time, green travel modes also contributed to enhancing the health level of urban residents, promoting social equity and harmony, and driving the comprehensive and sustainable development of the city's economy and society. However, the implementation of green urban travel optimization strategies was not something that could be achieved overnight and required the joint efforts of governments, enterprises, social organizations, and the public. Specific suggestions were as follows:

(1) Strengthen the construction of urban walking and cycling facilities. Walking and cycling are relatively flexible, low-carbon, and environmentally friendly, and are the best choice for short-distance travel. In urban construction, it is possible to consider building continuous walkways and cycling paths to ensure the safety of pedestrians and cyclists, focusing on areas with dense populations such as schools and residential areas.

(2) Strengthen the construction of the urban public transportation system. The distance that can be traveled solely by walking and cycling is limited. To reduce the extensive use of private cars, a comprehensive public transportation system is needed.

(3) Enhance intelligent monitoring systems to assist the transportation system. Strengthen big data monitoring to ensure the rationality of planned public transportation routes and station settings. In addition, continuous data monitoring and feedback can promptly identify and clear road obstacles, ensuring the accessibility and safety of various modes of travel.

(4) Increase citizens' willingness to participate in green travel. This requires not only the construction of improved green travel modes but also the promotion and encouragement of the concept and importance of green travel.

#### 5. Conclusion

This study, grounded in an examination of the urban design approaches and philosophies related to green travel in Vienna and Copenhagen, explored the feasibility of green travel strategies within urban design. Initially, green travel emphasized the selection of transportation modes and travel methods that have a minimal environmental impact, such as cycling, walking, and using public transportation. These methods not only reduced carbon emissions and air pollution but also helped alleviate traffic congestion and enhance urban operational efficiency. Effective urban design was a crucial foundation for supporting green travel; cities should have prioritized the development of public transportation systems, improving the coverage and accessibility of transit networks to decrease the reliance on private vehicles, thereby reducing traffic congestion and air pollution. Additionally, dedicated bicycle lanes and pedestrian paths provided a safe and convenient environment for cycling and walking, encouraging citizens to choose more environmentally friendly modes of travel.

As renowned livable cities worldwide, their green travel plans were not without flaws and presented certain drawbacks. For instance, there was significant financial pressure from initial investments and high maintenance costs for facilities in the later stages. From the user's perspective, transitioning from private car travel to walking, cycling, and public transportation required an adjustment period. In the future, interdisciplinary collaboration beyond the aforementioned concepts and methods, integrating traffic engineering, environmental science, sociology, and other disciplines, could have led to more scientific, rational, and humanized planning strategies by considering various aspects comprehensively. While this paper discussed the relationship between green travel and urban design and proposed several strategies and suggestions, it lacked specific data support. The case selection was also somewhat one-sided and may not have represented the development status of most cities. The strategies were generalized and lacked specific policy recommendations tailored to the particular conditions of specific cities.

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