technical transactions

No. 2025/013

architecture and urban planning

sciendo

Pedalling Toward Sustainability: A Comparative Study of Bicycle Policies in Stavanger, Norway and Kraków, Poland

Fabio Hernández Palacio

fabio.hernandez@uis.no | https://orcid.org/0000-0003-2437-7067

Department of Safety, Economics and Planning,
Faculty of Science and Technology,
University of Stavanger, Norway

Karolina Dudzic-Gyurkovich

karolina.dudzic-gyurkovich@pk.edu.pl |
https://orcid.org/0000-0002-9610-7288

Faculty of Architecture,
Cracow University of Technology

Scientific Editor: Mateusz Gyurkovich, Cracow University of Technology
Technical Editor: Aleksandra Urzędowska, Cracow University of Technology Press
Typesetting: Anna Pawlik, Cracow University of Technology Press

Received: July 14, 2025
Accepted: October 9, 2025

Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing interests: The authors have declared that no competing interests exist.

Citation: Hernández Palacio, F., Dudzic-Gyurkovich, K. (2025). Pedalling Toward Sustainability: A Comparative Study of Bicycle Policies in Stavanger, Norway and Kraków, Poland. *Technical Transactions, e2025013*. https://doi.org/10.37705/TechTrans/e2025013

Abstract

This study compares bicycle policies in two mid-sized European cities: Stavanger, Norway, and Kraków, Poland, to explore how cycling is being integrated into broader strategies for climate-neutral urban mobility. The research employs qualitative, comparative analysis to evaluate key dimensions, including infrastructure quality, planning frameworks, funding and governance, cultural attitudes, and integration with public transportation. The findings reveal contrasting institutional conditions: Stavanger benefits from legally binding, coordinated frameworks that support stable implementation, whereas Kraków relies on fragmented planning instruments and shifting political will, despite recent progress. However, both cities share similar challenges such as modest modal shares, car dependency, and behavioural inertia. Kraków demonstrates notable bottom-up innovation, particularly in multimodal integration and public engagement, while Stavanger offers a model of institutional coherence and accountability. The study highlights the importance of a successful cycling strategy, demonstrating that it requires more than infrastructure expansion and good maintenance; it also depends on how well cycling is integrated within legal, spatial, cultural, and financial systems. Lessons from these cases can inform both planning and governance efforts, as well as broader initiatives aimed at aligning mobility policy with sustainability and climate goals.

Keywords: Cycling, urban development, bicycle policy, sustainability

1. Introduction

Bicycle transportation is being promoted as a sustainable alternative for urban mobility. Bicycles offer multiple advantages as a means of transportation: they offer competitive speeds compared to other modes in compact urban areas, require modest infrastructure and low maintenance costs, take up little space, provide significant affordability compared to other modes, and have a low environmental impact due to noise or emissions (Gössling & Choi, 2015). However, despite all these advantages, the automobile, which is largely uncompetitive with bicycles in many respects, remains the dominant mode of transportation in most cities (Urry, 2004; OECD, 2024). The reasons are multiple and complex, but can be grouped into three main aspects. The first is that cars are not only seen as a means of transportation but also as a symbol of social status. The second is that cars are deeply embedded in local and national economies, and cities have developed extensive car infrastructure, shaping their form to make driving easier and more necessary, notably by expanding their areas with low-density, car-dependent developments.

This study compares the biking strategies of two cities: Stavanger, Norway, and Kraków, Poland. The two cities differ in many aspects; Kraków is a larger, more compact, and less affluent city than Stavanger. However, Kraków's economy has been growing rapidly, and the city is becoming increasingly sprawled and car-dependent. In contrast, Stavanger is growing at a slower pace, and the city has been implementing urban densification strategies to reverse the long-standing trend of sprawl and car-oriented development. Both cities are part of the EU Mission: Climate-Neutral and Smart Cities, aiming to enhance the use of bicycles as part of their commitment to climate neutrality. Both cities have similar cycling shares and have been applying strategies to improve them for several years.

This article proposes to explore the following research questions:

- In what ways do Stavanger and Kraków differ in their use of cycling policy as a tool for achieving climate-neutral urban mobility?
- What are the strengths and limitations of cycling policies in Stavanger and Kraków?

The remainder of the article is organised as follows: Section 2 defines the main concepts and describes the methodological approach. Section 3 compares the urban contexts of Stavanger and Kraków and summarises their sustainability goals. Section 4 describes the cycling policy landscape for both cities. Section 5 develops a comparative discussion, highlighting similarities and differences. Section 6 concludes the article with a reflection on what each city can learn from the other, revisits the research questions, and suggests areas for future research.

2. Theoretical Framework and Methodology

This section provides a brief introduction to the concepts of sustainability and carbon neutrality as foundations for a mobility shift, outlines the theoretical grounding for bicycle promotion, and concludes with an overview of the methodological approach.

2.1. Sustainability, carbon neutrality, and cities

Economic growth has been the primary instrument for improving human development and social prosperity; however, this has come at a significant environmental cost. The concept of sustainability seeks to reconcile social prosperity and economic growth with environmental conservation (Adams, 2006). Therefore, sustainability has been depicted as an interaction of three dimensions: the economy, the society, and the environment. What to prioritise

https://doi.org/10.37705/TechTrans/e2025013

and how to deploy strategies to improve sustainability remains a matter of contradictions and debate (Strange & Bayley, 2008). The dominant techno-optimistic view is that, thanks to more efficient and cleaner technologies, it is possible to enhance individual well-being and achieve more equitable societies through environmentally friendly economic development. In this way, it can be possible to achieve the famous Brundtland Report vision of a development that 'meets the needs and aspirations of the present without compromising the ability to meet those of the future' (WCED, 1987).

Carbon-neutrality has emerged as a concept related to sustainability, with a strong emphasis on the environmental dimension. Carbon emissions are a primary contributor to the current climate crisis. Therefore, the urgency is to reduce them where possible and to deploy mechanisms to compensate for the remaining emissions, such as paying for tree planting or investing in carbon-capture technologies. According to Ziegler (2016), this concept has gained popularity because it empowers society to act on what is feasible and allows for mechanisms to offset emissions that are more challenging to cut. The European Union has developed the European Green Deal to achieve climate neutrality by 2050, which requires a drastic reduction of carbon emissions. Transforming the car-based mobility system (15% of the EU27 CO2) is one of the main areas of action (Wolf, 2021). In this area, the role of local policies is crucial in achieving the expected reductions. Both Stavanger and Kraków are part of the EU Mission for 100 Climate-Neutral and Smart Cities by 2030.

Carbon neutrality goes beyond technological substitution. Technologies are deeply embedded in societies, not only in habits and norms but in the shape of the built environment itself. For example, decades of car-based mobility have shaped low-density environments that are heavily dependent on cars. Replacing internal combustion with electric mobility can improve emissions to a certain extent. However, low-density urban areas are also inefficient in multiple ways, which also affects other dimensions of carbon neutrality and sustainability in broader terms. Urban densification and transport-oriented development are two of the most popular strategies for achieving more sustainable cities. These two are often combined and aim to coordinate the location and concentration of functions with public transportation, while also encouraging walking and cycling (Poklewski-Koziełł et al., 2023). In this way, cities can avoid urban sprawl, which implies overextended infrastructures that are expensive for public administrations to operate. People can also reduce their car dependency, which can take a significant portion of their personal income and may also involve longer commute times (Saeidizand et al., 2022). Moreover, cars, whether with internal combustion engines or electric ones, require a substantial amount of space to operate and pollute the environment during both their production and operation.

Cycling, due to its affordability, active mobility nature, and modest infrastructure requirements, emerges as the ultimate carbon-neutral transport mode in medium-sized urban areas such as Stavanger and Kraków, which can benefit from the moderate complexity of the urban system and relatively short distances. However, this type of cities faces distinct challenges when compared to large metropolises. Limited municipal budgets, which in theory should favour cycling due to its low infrastructure cost, often result in the opposite. Despite its affordability, cycling infrastructure remains underfunded, as financial resources are frequently diverted to car-centric or mass transit projects instead (Leung, 2018). Moreover, medium-size cities' spatial structures often include dispersed settlements or suburban-style development, which reduces the practicality of cycling for longer or indirect trips. As noted by Pinto et al. (2010), spatial fragmentation significantly restricts urban mobility and service accessibility, creating structural barriers to sustainable transport in medium-sized urban areas.

Additionally, the institutional capacity for mobility planning may be weaker, which can lead to fragmented or reactive policy implementation rather than

strategic, long-term investment in cycling infrastructure. Medeiros and van der Zwet (2020) argue that medium-sized cities often struggle with unstable governance frameworks, relying heavily on external funding cycles that hinder consistent long-term planning. Similarly, Leung (2018), in a review of financing models for bikeways, shows that reliance on project-based or short-lived funding sources frequently undermines the sustainability of cycling initiatives.

Interestingly, comparative research across 18 countries has shown that medium-sized cities are often safer and less chaotic for cyclists than large metropolises. However, they may still suffer from infrastructure gaps and governance limitations (Useche et al., 2024). In Poland, for instance, cities of this size have made visible progress in expanding bike-sharing systems and infrastructure. However, these efforts are often undermined by a car-oriented planning culture and weak enforcement mechanisms, which limit the effectiveness of broader cycling policies (Jarosz & Springer, 2023).

2.2. Cycling policy, bikeability, and behavioural change

Cycling has several advantages in the three dimensions associated with sustainability. From an economic perspective, bicycles require modest infrastructure to operate, which can be built and maintained at a fraction of the cost of other modes of transport. Investments in cycling infrastructure, particularly in compact and multifunctional urban areas, can not only increase usage but also generate measurable returns in transportation efficiency. For example, Shahriari et al. (2024) indicates that improvements to bike lanes in Lyon and Paris significantly boosted cycling usage, while Brey et al. (2017), in a cost-benefit analysis of Seville's extensive cycling network, demonstrates substantial economic and social returns, including savings in travel time, vehicle use, infrastructure maintenance, healthcare costs, traffic accidents, and air pollution. This results not only in economic benefits for local authorities operating transport systems, but also in minimal costs per kilometre travelled for users, as bikes are more affordable than cars and, in many cases, are also competitive with the cost of public transport (Gössling & Choi, 2015; Gössling et al., 2019).

Socially, cycling can revitalise public spaces, foster interaction between individuals, and reduce healthcare costs by promoting physical activity (Pucher & Buehler, 2010). Evidence from post-industrial regions such as Silesia, Poland, demonstrates that bike-sharing systems provide affordable mobility, strengthen community connectivity, and support social cohesion, with users highlighting health and well-being as key benefits (Wolniak & Turoń, 2025). Additionally, cycling stimulates local economies by supporting small businesses in inner-city areas that rely on vibrant, accessible public spaces.

Environmentally, cycling requires minimal space, produces negligible noise, and emits almost no greenhouse gases, making it one of the most environmentally friendly and carbon-neutral transportation modes. By replacing short car trips with cycling, congestion is reduced, air quality improves, and reliance on fossil fuels is lowered. A study in Milan illustrates these benefits: even under high levels of air pollution, systematic cycling generated substantial public health and environmental advantages, with economic gains estimated at tens of millions of euros per year, rising to hundreds of millions if cycling levels matched those of more bike-friendly European cities (Guariso & Malvestiti, 2017).

However, despite the multiple advantages of cycling, implementing successful cycling policies that lead to higher shares of bicycles in daily urban transport is challenging (Parkin et al., 2007). Still, the implementation of cycling policies has gained force as a tool to improve local sustainability and achieve carbon neutrality. One of the biggest challenges lies in reversing decades of low-density car-oriented development. To function properly as a daily mode of transport, cycling requires compact urban areas with an adequate distribution of functions that facilitate proximity to users, given its low speed and, therefore, its limited

https://doi.org/10.37705/TechTrans/e2025013

capacity to reach daily destinations several kilometres away (Kesarovski & Hernández-Palacio, 2022). That should not be a problem, since many European cities have large compact cores, developed before the popularisation of the automobile. Nonetheless, compactness is not everything when it comes to bikeability. Instead, compactness is one of several conditions that contribute to bikeability (Reggiani et al., 2022). Other conditions include qualities that enhance the ease, convenience and safety for cycling, such as dedicated lanes, safe intersections, low traffic stress, and easy and safe bike parking. These aspects are often addressed in cycling policies worldwide.

Deploying successful cycling policies that increase the number of daily cyclists requires more than infrastructure and incentives. It requires behavioural change; this involves transforming the habits and values of commuters that influence their choice of daily transport modes. In this case, the ultimate purpose is to encourage car users to adopt bicycle use. According to Pucher & Buehler (2008), the success of cycling policies in countries such as The Netherlands, Denmark and Germany combine the improvement of infrastructure (dedicated lanes and parking), their integration with public transport, extensive educational and motivational campaigns, combined with policies to make driving expensive and inconvenient, particularly in compact city cores through extra fees, limited parking, and lower speeds. These policies are also articulated with land-use policies that promote compact, mixed-use developments, thereby enhancing proximity and making cycling a feasible transportation mode. According to the Dutch Expertise Centre for Cycling Policy, a successful cycling strategy needs to be "continuous and integral" (Fietsberaad, 2009). Continuous refers to the sustainability of cycling policies in the long term, encompassing political commitment, planning, implementation, and monitoring. Integral refers to the policy conception articulating infrastructure, traffic policy, and incentives.

2.3. Methodological approach

This study employs a comparative policy analysis approach, aiming to evaluate and contrast the cycling strategies of Kraków, Poland, and Stavanger, Norway. While the two cities differ in population size, the comparison focuses on institutional and policy frameworks rather than demographic similarity. The method is grounded in a qualitative, interpretive framework that emphasises the contextual analysis of urban planning documents, strategic policies, and institutional practices relevant to cycling. The central aim is to explore how each city integrates cycling policy within its broader sustainability and climate neutrality objectives, and to assess the coherence and effectiveness of these efforts.

The results section is organised into three main parts. Sections 3 and 4 are primarily descriptive, outlining the broader urban contexts of Stavanger and Kraków and presenting the cycling policy landscape in each city. Section 5 develops a comparative discussion, synthesising the findings across key thematic dimensions that reflect the legal, structural, and functional aspects of cycling policy. These dimensions include: the ambition and scope of policy objectives, funding structures and governance mechanisms, the quality and spatial distribution of cycling infrastructure, the cultural context and modal share of cycling, and the degree of integration with other transport modes, particularly public transport. Section 6 complements this discussion with a summary table, which provides a concise overview of the main similarities and differences between the two cases.

The primary sources of data include official planning documents, policy strategies, and statistical indicators. In the case of Stavanger, the analysis draws on municipal strategies, including the city's climate contract, cycling infrastructure plans, travel behaviour surveys, and implementation guidelines issued by the Stavanger municipality. For Kraków, the analysis incorporates

various documents, including the Sustainable Urban Mobility Plan for the metropolitan area, the General Municipal Plan, Local Development Plans, and the Technical and Implementation Standards for Cycling Infrastructure. These are supplemented with national strategies, EU-level directives, and academic studies that address issues of mobility, safety, policy effectiveness, and urban form.

Recognising the institutional and socio-cultural differences between Poland and Norway, the study seeks to uncover both convergent trends and context--specific constraints in the governance and practice of cycling promotion. Of particular interest are the varying degrees of legal enforcement, financial commitment, and cultural acceptance that shape the practical outcomes of cycling policy. This approach enables a nuanced comparison that highlights not only structural and policy-level factors but also the deeper societal conditions that either enable or impede sustainable transport transitions.

3. Urban Context and Sustainability Goals

3.1. Stavanger

Stavanger Municipality has a population of approximately 145,000 (as of 2024) and is the capital of Rogaland County, playing a central role in Norway's oil industry. Thanks to its connection to the oil industry, the city has a relatively young and diverse population, with a high proportion of inhabitants under 40 years of age and a significant percentage of international residents. Education levels are high, and employment is substantial in sectors such as energy, technology, education, and utilities. Stavanger is part of the Nord-Jæren region, which comprises the municipalities of Stavanger, Sandnes, Sola, and Randaberg, forming a polycentric urban agglomeration with a combined population exceeding 240,000. This region is one of Norway's six functional urban areas (OECD, 2013), characterised by high population density, strong economic integration, and a high rate of daily commuting for work and education purposes. The Nord-Jæren functional urban area is characterised by a combination of dense urbanisation patterns in several core areas, particularly in municipal urban centres, and large areas of medium-to low-density, discontinuous urban development. The region's low-density urban development is highly car--dependent. However, the regional authorities have been implementing urban densification policies and a strong focus on sustainable mobility, including public transportation and bicycle infrastructure.

Stavanger is part of the EU Mission: Climate-Neutral and Smart Cities, to achieve carbon neutrality by 2030. Strategies to achieve this goal span several sectors. For example, in transportation, they include the electrification of road transport, strengthening public transport, and increasing cycling and walking. In the building and construction sector, they include improving energy efficiency through the use of more efficient technologies. Similar strategies for adopting clean technologies also encompass sectors such as waste management, energy production and distribution, and maritime transport. (Stavanger Kommune n.d.-a).

According to the National Travel Surveys, Stavanger has increased its share of cycling gradually from 4% in 2014 to 10% in 2022. However, the 2024 survey shows a slight decline to 9%. The Nord-Jæren region exhibits a similar pattern, with an increase from 3% in 2014 to 8% in 2022; however, stagnation has occurred over the last two years (Staten Vegvesen, n.d.a). A study from Pritchard and Lovelace (2022) on the cycling potential for the Stavanger Region, using the «Propensity to Cycle Tool», estimates that Nord-Jæren can reach a share of 35% for cycling.

https://doi.org/10.37705/TechTrans/e2025013

3.2. Kraków

Kraków is the second-largest city in Poland, with a population of approximately 800,000 (as of 2024) (*GUS*, 2025), and serves as the capital of the Lesser Poland Voivodeship. As a historic royal seat and a UNESCO World Heritage site, Kraków has long been a centre for education, culture, and tourism. It hosts major academic institutions and several global business services, technology, and international corporations, which have spurred demographic growth and socio-economic diversification. Kraków retains a compact historical urban core; however, it is increasingly affected by suburbanisation, dispersed settlement patterns, and car-dependent development on its periphery, a trend that challenges sustainable urban mobility and puts pressure on public infrastructure (KPM 2030, 2022; Urbanek, 2021).

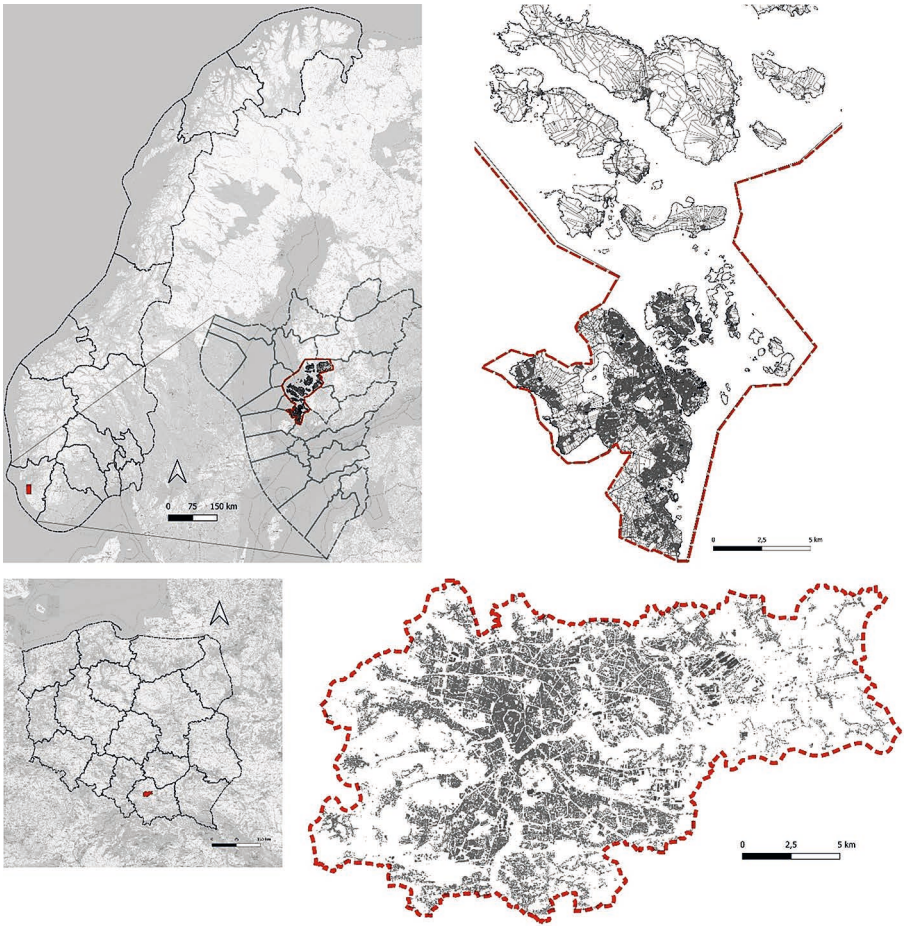

Fig. 1. Locations of Stavanger (top) and Kraków (bottom) within their respective countries with urban structure schemes showing both cities. Source: Author's own elaboration based on open spatial data (own elaboration)

Kraków, like Stavanger, is part of the EU's Mission for 100 Climate-Neutral and Smart Cities by 2030 and has committed to achieving its sustainability goals. This direction is articulated in the Kraków Development Strategy, which sets a vision for a resilient, inclusive, and climate-neutral city by 2030, with an outlook to 2050 (UMK, 2005). Among the main areas of focus are sustainable urban mobility, circular economy, and public health. Improving cycling infrastructure, integrating green transport, and promoting low-emission development are central components of this document's agenda. Additionally, as a popular tourist destination, Kraków recognised the need to manage tourism more effectively, prevent overtourism, and promote a sustainable approach that considers the natural environment, protects cultural heritage, and enhances residents' quality of life (UMK, 2021).

The situation of cycling in Kraków should be understood in the broader national context. Across Poland, the share of cycling in the modal split remains relatively low compared to other European countries. According to available data, only 6% of surveyed Polish citizens report using a bicycle or scooter as their primary mode of transportation, which is below the EU average of 8%. (Yanatma, 2023). Significant disparities exist between cities: larger urban centres tend to be more bike-friendly with relatively better-developed infrastructure, whereas small and medium-sized towns often lack adequate cycling facilities (Jarosz & Springer, 2023; Okraszewska et al., 2016; Włodarek & Olszewski, 2020). In Kraków, a 2021 report based on 2018 data indicates that 6.9% of trips in the city were made by bicycle. This reflects a significant growth in cycling's role within the urban mobility system, compared to the 2013 data, where the cycling share was assessed at only 1.2% of total trips (*Pedestrian Space*, 2021; Rudolph et al., 2021). Despite this growth, the bicycle share remains low.

4. Cycling Policy Landscape

This section outlines the broader urban, demographic, and spatial contexts of Stavanger and Kraków, situating their cycling policies within local development patterns and sustainability ambitions. Each city has its distinct structure, growth dynamics, and environmental commitments, which are essential for promoting cycling.

4.1. Stavanger Cycling Policy Landscape

Cycling has been a fundamental part of Stavanger's sustainable transportation strategy. According to the annual municipal bicycle survey (data from 2013 to 2023), the city has experienced a notable increase in the number of cyclists, particularly in the early years (Stavanger Kommune, 2024). Infrastructure improvements and a cultural shift toward greener mobility drove this growth. However, in recent years, the trend has stagnated, with a slight decline observed in 2023. This decline is partly attributed to the implementation of a free public transport period during the second half of that year.

Bicycle use varies significantly depending on the season. In 2023, approximately 32% of people reported cycling frequently during the summer, while 20% continued to do so during the winter months. The rise of e-bikes has also significantly contributed to maintaining cycling levels, with 26% of cyclists now using them, especially women. Respondents stated that their primary motivation for cycling is due to the health benefits and convenience. While the perception of cycling infrastructure has improved, residents still believe there is room for improvement, particularly in terms of connectivity and safety. Overall, Stavanger's cycling culture is well-established; however, its future growth may depend on how the city balances cycling with other sustainable transportation options.

The central objective of Stavanger's cycling policy is to create a safe, accessible, and attractive environment for cyclists (Stavanger Kommune, n.d.-b). By doing so, the municipality aims to encourage more residents to choose the bicycle over the car. One of the strategy's key elements is the development of a network of 11 major cycling routes (part of the regional cycling network). These routes, designed to be direct, well-signposted, and prioritised for maintenance in summer and winter, form the backbone of the city's cycling infrastructure. Each route features separate lanes or bicycle-priority streets to ensure safety and network continuity.

In line with national regulations, bicycles are permitted in all pedestrian areas in Norway, which provides a flexible legal framework that supports the multimodal use of shared spaces. Stavanger's cycling infrastructure comprises a mix of pedestrian and cycling paths, dedicated cycling lanes,

https://doi.org/10.37705/TechTrans/e2025013

and cycling roads. However, these vary significantly in terms of composition, quality, continuity, and distribution across the city (Figure 2). The predominant component of the cycling network is pedestrian paths with allowed cycling; cycling lanes or cycling roads-those designed specifically for bicycle traffic--constitute a smaller portion of the overall layout. Currently, the network does not yet match the scale or quality of cycling infrastructure seen in leading cities like Copenhagen or Utrecht; nevertheless, in recent years, Stavanger has made progress, showing the municipality's will to prioritise cycling.

Another critical component is the emphasis on bicycle parking. The municipality has published a detailed bicycle parking guide that outlines the principles of good design. It includes recommendations on location, types of parking, location, lighting, and maintenance. The guide emphasises that every bicycle journey begins and ends with parking and that a poorly functioning bicycle parking system can discourage bicycle use.

The strategy also includes a public bike-sharing system provided by the regional public transport operator Kolumbus, support for regulating electric scooters operated by private providers, and subsidies for purchasing electric bicycles. Additionally, the municipality has implemented citizen feedback tools and conducted periodic surveys to identify areas for potential improvement based on user needs.

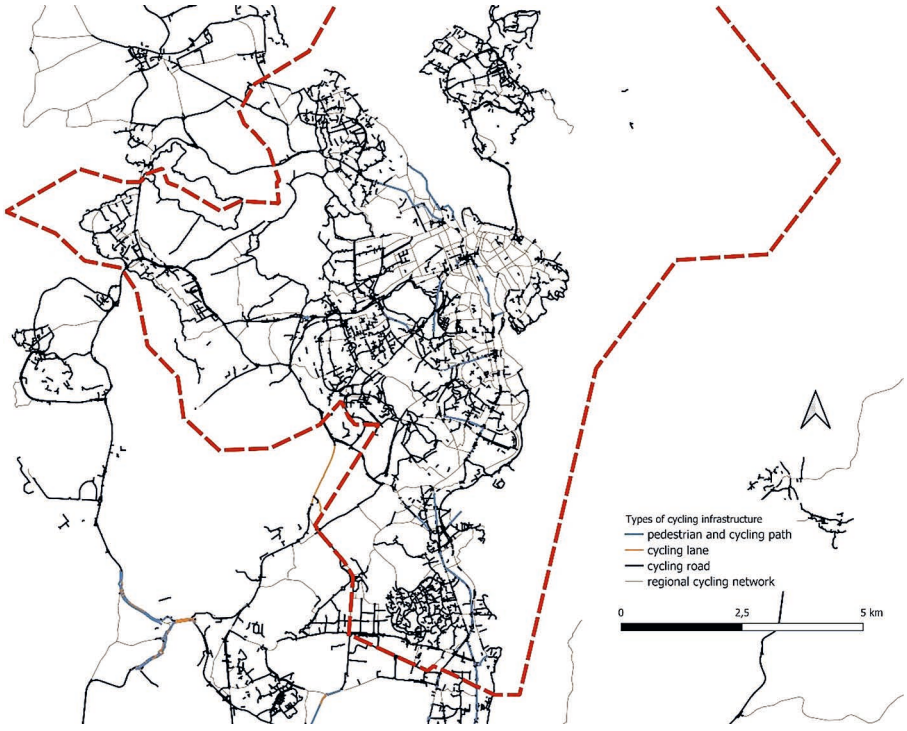

Fig. 2. The cycling map of Stavanger. Source: own elaboration based on the open spatial data (own elaboration)

4.2. Kraków Cycling Policy Landscape

Cycling has emerged as an important component of Kraków's sustainable mobility strategy over the past decade. Although the city has been car-centric for decades, it is making efforts to expand its cycling infrastructure and increase the number of cyclists. Between 2010 and 2021, the length of dedicated cycling infrastructure in Kraków increased from approximately 96 km to over 260 km, representing a substantial improvement. Despite the progress in infrastructure, the city still faces challenges in raising the modal share of cycling.

To encourage cycling on everyday trips, the city has launched an interactive map that displays all the bicycle infrastructure, including service points, bike parking, and bike lanes. This map, although undoubtedly a valuable tool, also

highlights the lack of continuity in the cycling network. The layout is fragmented, characterised by abrupt route endings, inconsistent signage, and frequent gaps in safe connections (Figure 3). Additionally, only a portion of the network consists of separated cycling roads or protected lanes; a significant share relies on contraflow lanes on regular streets—solutions that are often less convenient and may compromise safety, particularly in mixed-traffic environments. (Public Transport Authority, 2025).

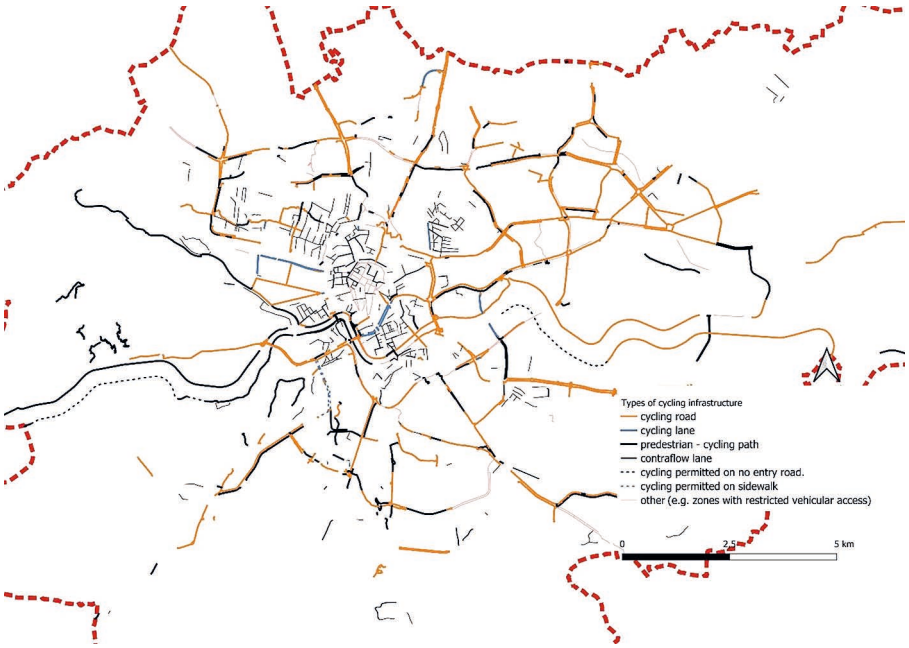

Fig. 3. The cycling map of Kraków. Source: own elaboration based on the open spatial data (own elaboration)

The ambitious goals envisioned in the Sustainable Urban Mobility Plan (SUMP), to be implemented in 2025 for the entire metropolitan area, aim to increase the cycling modal share in the city, as well as in neighbouring municipalities, where the lack of infrastructure poses the biggest obstacle to bike use. To achieve this, the SUMP outlines measures such as the development of inter-municipal cycling corridors, improved last-mile connectivity to public transport hubs, and standardised infrastructure design across municipal boundaries to ensure safety and continuity for cyclists (Metropolia Krakowska, 2025). Another key objective of the SUMP is better integration with public transport. It recognises the need for seamless multimodal connectivity, including coordinated timetables, secure bicycle parking, and the integration of cycling with public transport fare systems.

Despite its importance for mobility planning and funding priorities, SUMP is not legally binding unless its components are formally adopted into municipal regulations or plans. This results in a situation where the only way to secure the bike infrastructure placement is to incorporate it into the Local Development Plan (MPZP), which is currently the only legally binding spatial planning instrument at the local level in Poland. Typically, an MPZP covers only a small portion of the city, usually not exceeding 100 hectares, making it a fragmented and limited tool for implementing citywide cycling infrastructure.

Seasonal variation in cycling use is evident, with higher volumes during the spring, summer, and early autumn months, particularly noticeable on bike routes that run along recreational corridors. Although precise surveys are not available, based on the automatic measurement data from 17 points across the city, an estimation can be made that cycling is highly related to the average temperature and the rainfall, which confirms a strong seasonal-weather sensitivity of cycling behaviour (Public Transport Authority, 2025).

https://doi.org/10.37705/TechTrans/e2025013

The rising popularity of e-bikes has contributed to increased ridership in Kraków, although comprehensive usage data remains limited. Nevertheless, the city has implemented two e-bike sharing strategies that are showing steady growth. The first centres around Park-and-Ride (P+R) locations, offering a fleet of electric bikes for commuters travelling from suburban areas, such as Skawina, into the city centre. Launched in 2020 with just one station and 43 bikes, the service has since expanded to approximately 80 e-bikes across seven Park and Ride (P+R) facilities. The system is free to use, enhancing last-mile connectivity and encouraging multimodal travel. Similarly, the LajkBike program, introduced by the Public Transport Authority in early 2023, serves as a long-term rental system for both traditional and electric bicycles. Initially launched with a fleet of 500 bikes, the program operates on an affordable subscription basis, offering accessible mobility options to a broader range of residents (Public Transport Authority, 2025).

Additionally, Kraków has implemented "soft" initiatives aimed at promoting bicycle use among different groups. Schools participate in the "Cycling May" initiative, a nationwide month-long campaign promoting healthy lifestyles and sustainable, active mobility among school children, their teachers, and parents. Started in 2016 in Gdańsk, it has expanded significantly to over 30 cities, including Kraków (Rowerowy Maj, 2025). Another campaign, called "By Bike to Work", is targeted at employees and companies, especially workplaces in Kraków with at least 50 staff members, and encourages commuting by bike rather than car. It operates as a gamified challenge where participants log their trips, earn rewards, and contribute to broader sustainability goals. In 2025, nearly 3,000 users from 184 employers in Kraków logged over 84,000 bike commutes, which shows the potential to shift mobility habits in the workplace (UMK, 2025).

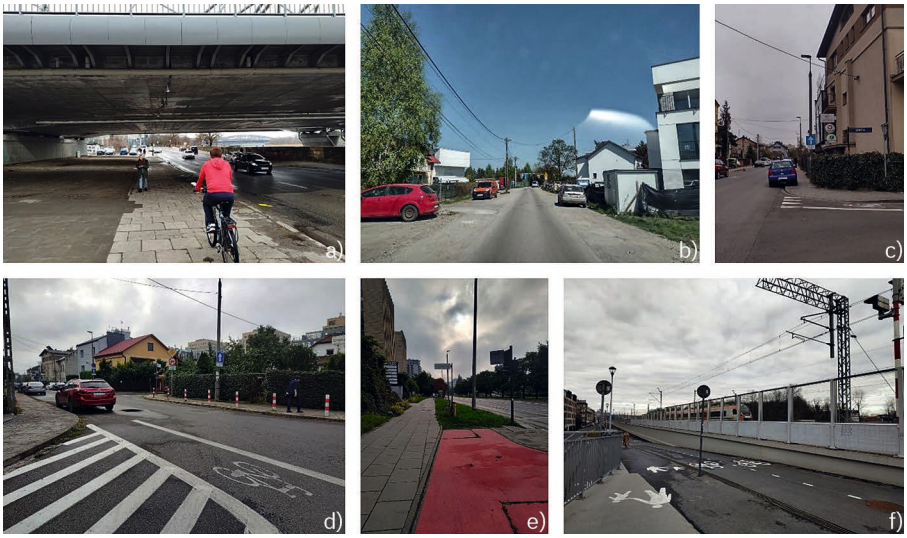

Fig. 4. Conditions of cycling infrastructure in Kraków: a) no cycling path, under the viaduct results in cyclists choosing sidewalks; b) areas with poor conditions for cycling; c, d) contraflow lanes are not respected by car users; e) disconnected bike road; f) on key routes separate pedestrian and cycling lanes (photo by author)

Overall, the cycling landscape in Kraków reveals a city in transition. Notable progress has been made in terms of infrastructure expansion, information and service innovation (such as e-bike programs); however, several aspects remain inadequately addressed. These include the need for higher-quality, protected cycling routes, improved year-round maintenance, a more effective, integrated monitoring system to track cycling traffic and evaluate policy goals, and, above all, stronger public awareness to help shift mobility habits. In addition, planning challenges remain, particularly the lack of enforceable mechanisms in strategic documents, which complicates the implementation of consistent and continuous bike infrastructure.

Fig. 5. Conditions of cycling infrastructure in Stavanger: a) cycle path through Mosvatnetparken; b) shared-use roadway for pedestrians and cyclists; c) shared-use roads with priority for cyclists and prohibited parking; d) cycle path through Vålandparken; e) trunk cycle route connecting the municipalities of Stavanger and Sandnes (photo by author)

5. Comparative Discussion

In this section, a critical comparison is presented between the cycling strategies of Stavanger and Kraków across several dimensions to examine how different urban, institutional, and cultural contexts influence the implementation and outcomes of bicycle policy. Key differences and shared challenges are identified, discussed and summarised, providing insight into the broader conditions that shape urban cycling conditions.

5.1. Policy ambition and scope

Stavanger's cycling policy is well embedded within a broader climate strategy, which positions cycling as a central element of the sustainability goals. The cycling strategy outlines goals, implementation priorities, and monitoring and supporting instruments. The infrastructure planning is backed by national laws (Planning and Building Act, Road Act), which require sustainable transport inclusion in municipal plans and infrastructural investments. Additionally, Byvekstavtaler (Urban Growth Agreements) are legally binding, multi-level agreements between the Norwegian national government, county authorities, and municipalities in larger urban areas, such as Stavanger, Oslo, Bergen, and Trondheim. Their core aim is to limit car traffic growth and ensure sustainable urban mobility and development. These agreements specify mandatory infrastructure targets, budgets, timelines, and performance metrics, which makes cycling legally integrated into broader urban planning and subject to legal and financial accountability.

In this context, within the European Union, Poland remains among the few countries without a dedicated national cycling strategy. As a result, emerging cycling policies are heavily influenced by broader European Commission guidelines, particularly those related to sustainable transport development and urban mobility planning. At the national level, numerous documents emphasise the integration of cycling into urban transport systems, promoting it as a sustainable and health-conscious alternative to motorised transport (Kwiatkowski & Szymańska, 2021). However, in the absence of a cohesive national cycling policy, implementation remains uneven and depends on local policy directions. Spatial planning mechanisms, particularly Local Development Plans (MPZPs), are not centred on active mobility, as they primarily establish general land-use regulations rather than detailed provisions for cycling infrastructure.

https://doi.org/10.37705/TechTrans/e2025013

5.2. Funding and governance

In Stavanger, cycling investments are supported through Byvekstavtaler agreements that connect national, regional, and municipal funding to specific transport goals, such as reducing car use and improving cycling infrastructure. Under these agreements, municipalities like Stavanger receive earmarked transfers, such as revenues from road tolls, provided they meet clearly defined targets. This is part of a broader national strategy that ensures funds are tied to measurable results, making long-term planning more manageable (Stavanger Kommune, n.d.-b; Statens Vegvesen, n.d.a). The approach is supported by Norway's overarching National Cycling Strategy and the National Transport Plan, which establishes technical standards (such as the Sykkelhåndboka) and allocates matching funds for compliant local projects. This system promotes coordination across levels of government and aligns transport investments with national climate goals.

In Kraków, cycling infrastructure funding emerges from a patchwork of sources, including national subsidies, EU structural and cohesion funds, and municipal revenues. Since around 2018, the city has allocated 20 % of its annual paid-parking income to sustainable modes such as cycling and walking, which is a local funding mechanism adopted via a mayoral decree (Park4SUMP, 2025). On a regional level, Metropolia Krakowska is developing metropolitan cycling corridors (e.g., VeloMałopolska and VeloMetropolis) funded partly through the European Regional Development Fund and Cohesion Fund. Moreover, Kraków participates in EU Research and Development programs that support projects implementing cycling networks within ecological and low-emission strategies (Metropolia Krakowska, 2025). Despite these diverse streams, Kraków's approach remains fragmented, relying on EU funding cycles and local government priorities, which can lead to inconsistent planning and implementation delays.

However, in 2024, Kraków launched a dedicated task force to guide the development of its cycling infrastructure. This group of specialists and practitioners brings together municipal departments and local cycling NGOs. Its tasks include, among others, defining priorities in cycling development, coordinating investments, and ensuring integration with other urban projects (UMK, 2024). The task force is also expected to monitor implementation of cycling programmes and propose funding options for investments. This represents a step forward in achieving greater coherence and coordination in cycling governance in Kraków and may signal a stronger political will for long--term improvements.

5.3. Infrastructure quality and coverage

In terms of infrastructure quality and coverage, Stavanger benefits from a well-integrated and functionally connected cycling network that reflects a consistent planning approach. Key routes are designed to support commuter traffic, with a focus on directness, safety, and usability throughout all seasons. The city's infrastructure is continually enhanced by the addition of parking facilities, which, when developed, provide a better user experience. By contrast, Kraków's cycling network, while expanding, lacks spatial coherence and often fails to connect key destinations effectively. Gaps in the network, abrupt route endings, and varied design standards can reduce overall usability, particularly for daily commuters, which can be primarily attributed to safety concerns (Iwińska et al., 2018). While some efforts have been made to address these issues through regional coordination and digital tools, the current infrastructure still reflects a patchwork of interventions rather than a unified system.

The visual comparison of cycling infrastructure maps reveals substantial differences in both the predominant types of infrastructure and the overall

network density. In Stavanger, the network is dominated by mixed-use pedestrian and cycling paths, with fewer dedicated cycling roads or lanes, particularly outside the urban core. In Kraków, the infrastructure exhibits a diverse typology, including cycling roads, protected lanes, a substantial number of contraflow lanes, and urban core areas where regular car traffic is restricted.

It is worth noting that cycling infrastructure is highly dependent on the urban model and the trajectory of development. In Stavanger, infrastructure planning is significantly constrained by the city's suburban, low-density layout. The Stavanger central urban area features a dense, grid-based layout, providing good street connectivity. However, there are significant disparities between the urban core and the peripheries. Outside the city core, densities are much lower, mainly because much of the periphery follows Radburn-style planning, characterised by cul-de-sacs and disconnected street networks. This makes cycling an inefficient alternative to car travel. Even ambitious projects, such as cycling tunnels and corridors, struggle to fully compensate for these structural limitations, as reconfiguring the urban fabric is nearly impossible without large-scale redevelopment.

Kraków is a larger city, and its historical core density and street continuity provide a much stronger foundation for cycling in this area. However, disparities also exist between different parts of the city, with the highest population densities found in the historical centre and in large-scale post-war housing estates. Much of the peripheral urban area is dominated by low-density single-family housing, particularly in districts developed on the sites of former villages that were incorporated into the city.

The street layout in these low-density zones, unlike the compact and well-connected grid of the historical centre, tends to be loosely organised, discontinuous, and car-oriented, with long blocks, dead-end streets, and limited cycling permeability. These morphological patterns create significant challenges for extending safe and attractive cycling networks. As a result, Kraków's central urban form has the potential to support cycling. At the same time, its suburban areas exhibit similar structural limitations to those seen in Stavanger, where retrofitting cycling infrastructure becomes both logistically complex and financially demanding.

5.4. Modal share and cycling culture

Stavanger and Kraków both exhibit relatively modest cycling modal shares, yet the cultural context and underlying dynamics differ significantly. In Stavanger, cycling has gradually gained acceptance as a viable daily transport mode, supported by a strong environmental consciousness and institutional efforts to normalise cycling through infrastructure, incentives, and visibility. Although the modal share remains below the potential suggested by cycling scenario models, the city benefits from a more established cycling culture, with some stable rates of all-season cycling and growing adoption of e-bikes. Public surveys indicate that health, convenience, and environmental concerns are key motivators, and cycling is increasingly seen as a mainstream option rather than a niche activity.

Kraków's cycling modal share remains low, with cycling often perceived as a recreational activity rather than a means of transportation. The rapid growth of infrastructure and promotional campaigns in recent years has begun to shift public attitudes, particularly among younger residents and commuters, contributing to the overall increase in cycling. However, as in the whole country, car dependency remains high, and cultural barriers persist, as cycling is still often seen as less safe, less practical, or less socially accepted compared to motorised transport (Szmelter-Jarosz et al., 2023; Wołek, 2018). As a result, behavioural change remains a critical challenge in advancing the city's cycling agenda.

https://doi.org/10.37705/TechTrans/e2025013

Additionally, the cycling rules remain vague and unclear, often becoming disincentives for cyclists. For example, the rule that obliges cyclists to use cycling paths and not cycle on sidewalks can create confusion and safety concerns, especially when the infrastructure is fragmented or poorly maintained. In Norway, in contrast, cyclists are permitted to share all pedestrian spaces, making the cycling experience easier and safer. This approach is advantageous in areas where bike paths are absent, narrow, or obstructed. Otherwise, cyclists are left with unsafe choices, either sharing roads with traffic or facing fines for using sidewalks. This legal ambiguity may deter less experienced users and undermine efforts to promote cycling as a viable mode of transportation in Poland.

5.5. Integration with public transport

Integration with public transport differs in both ambition and implementation between Stavanger and Kraków. In Stavanger, integration efforts have focused on enhancing access to public transportation hubs through safe cycling routes and secure bike parking facilities. The city promotes cycling as part of a broader sustainable transport network, but practical integration, such as fare systems or direct cycling–transit coordination, remains limited. Cycling and public transport are often treated as parallel alternatives rather than entirely complementary modes. Additionally, suburban low-density patterns pose challenges to making intermodal trips attractive and efficient. However, a notable exception is the Kolumbus e-bike service, which allows commuters to use electric bicycles included in their bus fare. This service is part of the broader HjemJobbHjem ("Home–Work–Home") program, which provides employees with subsidised access to both public transport and e-bikes, along with personalised travel planning (HjemJobbHjem, 2025).

Kraków has begun to integrate cycling and public transport more actively, particularly in recent years. The Sustainable Urban Mobility Plan (SUMP) outlines strategies for last-mile connectivity and intermodal travel, including the placement of e-bike sharing stations at Park-and-Ride (P+R) facilities and the development of unified metropolitan corridors. Although implementation is still in progress and lacks operational integration, it shows a clear goal to incorporate cycling into the public transport framework. The city's compact urban form offers a good foundation for this integration, provided that infrastructural and institutional gaps are addressed.

6. Comparative summary table

The table below provides a structured comparison of key cycling policy conditions in both cities: Stavanger and Kraków, based on the findings presented in Section 5. It highlights differences in governance, infrastructure, cultural factors, and policy integration to illustrate how each city approaches cycling as part of its sustainable mobility strategy.

Thematic area	Stavanger	Kraków	Comparative Insight
Policy ambition and scope	Cycling targets are embedded in climate and transport strategies, supported by national climate objectives and agreements.	Cycling is promoted in local sustainability plans and SUMP; it lacks a national cycling strategy or binding modal targets.	Stavanger benefits from national integration, whereas Kraków lacks an overarching policy alignment.
Funding and governance	Stable funding framework; national standards enforced through coordinated multi-level governance.	Funding is fragmented across EU, national, and local levels, and is reliant on project-based revenues.	Stavanger demonstrates structured and conditional funding, whereas Kraków's financing is piecemeal and less enforceable.
Infrastructure quality and coverage	Well-planned regional network with priority corridors; infrastructure constrained by suburban low-density form.	A dense and connected core network; peripheral areas are less developed; an emerging focus on shared and electric micro-mobility.	Both cities face contextual barriers; Stavanger has structural density limits, while Kraków has planning-related.

Modal Share and cycling culture	The cycling modal share is ~9%, with potential to increase to around 35%. It exhibits high seasonal variation and has a strong uptake of e-bikes.	The cycling modal share is ~7%; car dependency and cultural attitudes remain significant barriers.	Cultural acceptance is higher in Stavanger; Kraków is still building cycling norms and culture.
Integration with public transport	Limited operational integration; includes e-bike service in public transport offer; suburban layout hinders full intramodality.	Growing integration efforts; SUMP includes intermodal goals. Park-and-Ride e-bike stations have been implemented but are limited.	Stavanger offers functional, if limited, integration; Kraków has ambitious plans but is operationally underdeveloped.

7. Conclusion and policy recommendations

Despite sharing similar goals, the two cases illustrate different pathways and limitations in translating sustainability goals into real mobility practices. The comparison also underscores that even in more advanced and transparent governance contexts, such as the Stavanger model, modal shift can experience stagnation without further active interventions to reduce car dependency. Conversely, in less developed policy environments, as Kraków, strategic gaps can occasionally be bridged through targeted programs and local experimentation, but only up to a point. Ultimately, it is not the presence of cycling policy that determines its effectiveness, but the degree to which it reshapes everyday urban routines, space allocation, and institutional priorities.

Each city offers insights that can be used to strengthen cycling policy. Kraków could benefit from greater institutional coherence, legally binding frameworks, and long-term policy alignment, as seen in Stavanger. Putting cycling more firmly into spatial planning and securing multi-level governance would help overcome fragmented and inconsistent implementation. It could also potentially help improve the quality and safety of cycling solutions by securing the land allocated for cycling infrastructure. Conversely, Stavanger could learn from Kraków's emphasis on multimodal integration, which may boost the stagnant cycling share.

While the two cities differ in demographic scale, both can be regarded as mid-sized European urban centres, which makes their comparison relevant for understanding cycling policy in this context. The cases highlight that policy ambition must be accompanied by legal enforceability, cross-sector coordination, and sustained investment in high-quality infrastructure. Stavanger illustrates how strong governance can deliver consistency and institutional coherence, whereas Kraków demonstrates that meaningful progress can also emerge from bottom-up initiatives and local governance, even within fragmented and less coherent planning systems.

The study aimed to understand how Kraków and Stavanger utilise cycling policy to support climate-neutral mobility, and what factors help or hinder their efforts. The findings show that success depends less on having a policy and more on how it is integrated into planning, funding, and everyday culture. Stavanger's strength is its stable, rule-based system, but now it risks stagnation. Kraków is making efforts to catch up on decades of poor development, yet struggles with weak coordination and limited legal enforcement. This study demonstrates that the success of cycling policies depends on how well they align with the local context, including the planning framework and cultural landscape. Hence, the key insight is that cycling grows not just through new infrastructure, but also when it is fully integrated with everyday systems of planning, transportation, and behaviour.

Future research could focus on the performance of cycling policies over time concerning shifts in political leadership, public sentiment, and climate commitments. Further monitoring of cycling share would inform how cities respond to policy interventions and whether they can achieve lasting modal shifts. Comparative studies involving cities beyond Europe, for example, in rapidly urbanising regions, could offer valuable insights into how cycling policies adapt under different governance and cultural conditions. Two case studies

https://doi.org/10.37705/TechTrans/e2025013

differ in population scale, therefore focusing on central districts of comparable size in future analyses could allow for more direct evaluation of policy outcomes. Ultimately, interdisciplinary studies that link cycling with land use, housing, and economic resilience could help clarify its role in shaping sustainable urban development.

References

Adams, W.M. (2006). *The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century*. Report on the IUCN Renowned Thinkers Meeting, 29–31 January 2006. https://portals.iucn.org/library/sites/library/files/documents/Rep-2006-002.pdf (online: 20.05.2025).

Brey, R., Castillo-Manzano, J.I., Castro-Nuño, M., López-Valpuesta, L., Marchena-Gómez, M., & Sánchez-Braza, A. (2017). Is the widespread use of urban land for cycling promotion policies cost effective? A cost-benefit analysis of the case of Seville. *Land Use Policy*, *63*, 130–139. https://doi.org/10.1016/j.landusepol.2017.01.007

Fietsberaad, Expertise Centre for Cycling Policy. (2009). *Bicycle policies of the European principals: continuous and integral* (Fietsberaad Publications, Issue 7). https://www.cycling-embassy.org.uk/sites/cycling-embassy.org.uk/files/documents/Fietsberaad_publicatie7_Engels.pdf (online: 20.05.2025).

Gössling, S., & Choi, A.S. (2015). Transport transitions in Copenhagen: Comparing the Costs of Cars and Bicycles. *Ecological Economics*, *113*(Supplement C), 106–113. https://doi.org/10.1016/j.ecolecon.2015.03.006

Gössling, S., Choi, A., Dekker, K., & Metzler, D. (2019). The Social Cost of Automobility, Cycling and Walking in the European Union. Ecological Economics, 158, 65–74. https://doi.org/10.1016/j.ecolecon.2018.12.016

Guariso, G., & Malvestiti, G. (2017). Assessing the value of systematic cycling in a polluted urban environment. *Climate*, *5*(3), 65. https://doi.org/10.3390/cli5030065

Statistics Poland (*GUS*). (2025). https://krakow.stat.gov.pl/ (online: 27.06.2025).

HjemJobbHjem. (2025). https://www.hjemjobbhjem.no/rogaland/ (online: 20.05.2025).

Iwińska, K., Blicharska, M., Pierotti, L., Tainio, M., & de Nazelle, A. (2018). Cycling in Warsaw, Poland – Perceived enablers and barriers according to cyclists and non-cyclists. *Transportation Research Part A: Policy and Practice*, *113*, 291–301. https://doi.org/10.1016/j.tra.2018.04.014

Jarosz, A.J., & Springer, B. (2023). Carrots Without Sticks: Cycling Policy of Mediumsized Polish Cities. *Polish Political Science Review*, *11*(1), 46–68. https://doi.org/10.2478/ppsr-2023-0004

Kesarovski, T., & Hernández-Palacio, F. (2022). Urban density, accessibility, and proximities: mapping and understanding the relationship between urban densities and cycling accessibility to grocery shops in the 10-minute city in the context of the Stavanger metropolitan area. *Annual Conference Proceedings of the XXVIII International Seminar on Urban Form*, Glasgow.

KPM 2030. (2022). *Krajowa Polityka Miejska*. https://www.gov.pl/web/fundusze-regiony/polityka-miejska (online: 16.05.2025).

Leung, A. (2018). Alternative ways to pay? A review of non-government sources to fund bikeways. *Australasian Transport Research Forum*. https://www.researchgate.net/publication/333043590 (online: 27.06.2025).

Medeiros, E., & van der Zwet, A. (2020). Sustainable and integrated urban planning and governance in metropolitan and medium-sized cities. *Sustainability (Switzerland)*, *12*(15). https://doi.org/10.3390/su12155976

Metropolia Krakowska. (2025). Plan zrównoważonej mobilności metropolii krakowskiej i jej obszaru funkcjonalnego.

OECD. (2013). OECD Regions at a Glance 2013: OECD Publishing. http://dx.doi.org/10.1787/reg_glance-2013-en
OECD. (2024). *OECD Regions and Cities at a Glance 2024*. OECD Publishing. https://www.oecd.org/en/publications/oecd-regions-and-cities-at-a-glance-2024_f42db3bf-en.html (online: 21.05.2025).
Okraszewska, R., Grzelec, K., & Jamroz, K. (2016). Developing A Cycling Subsystem as Part of a Sustainable Mobility Strategy: The Case of Gdansk. *Scientific Journal of Silesian University of Technology. Series Transport*, *92*, 87–99. https://doi.org/10.20858/sjsutst.2016.92.9
Parkin, J., Ryley, T., & Jones, T. (2007). Barriers to Cycling: An Exploration of Quantitative Analyses. In D. Horton, P. Rosen, & P. Cox (Eds.), *Cycling and Society*. Ashgate Publishing Company.
park4SUMP. (2025). https://park4sump.eu/ (online: 27.06.2025).
Pedestrian Space. (2021). https://pedestrianspace.org/editors-notes-first-impressions-of-urban-mobility-in-krakow/ (online: 22.06.2025).
Pinto, A. J., Remesar, A., Brandão, P., Nunes Da Silva, F., & Fernando, S. (2010). Planning public spaces networks towards urban cohesion. *46th ISOCARP Congress 2010*.
Poklewski-Koziełł, D., Dudzic-Gyurkovich, K., & Duarte, C.M. (2023). Investigating urban form, and walkability measures in the new developments. The case study of Garnizon in Gdansk. *Land Use Policy*, *125*. https://doi.org/10.1016/j.landusepol.2022.106471
Pritchard, R., Lovelace, R. (2022). *Sykkelpotensial og bysykler. En beregning av potensialet for økt hverdagssykling og evaluering av bysykkelordningene på Nord-Jæren, i Trondheim og i Bergen* (Rapport 14-2022, NORCE Helse og samfunn).
Public Transport Authority. (2025). *ztp*. 2025. https://ztp.krakow.pl/rower (online: 22.05.2025).
Pucher, J., & Buehler, R. (2008). Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany. *Transport Reviews*, *28*(4), 495–528. https://doi.org/10.1080/01441640701806612
Pucher, J., & Buehler, R. (2010). Walking and cycling for healthy cities. *Built Environment*, *36*(4), 391–414. https://doi.org/10.2148/benv.36.4.391
Reggiani, G., van Oijen, T., Hamedmoghadam, H., Daamen, W., Vu, H.L., & Hoogendoorn, S. (2022). Understanding bikeability: a methodology to assess urban networks. *Transportation*, *49*(3), 897–925. https://doi.org/10.1007/s11116-021-10198-0
Rowerowy Maj. (2025). *Rowerowy Maj*. https://rowerowymaj.eu/# (online: 22.05.2025).
Rudolph, F., Werland, S., & Jansen, U. (2021). *Sustainable mobility in Bratislava. An indicator-based assessment*. http://www.wupperinst.org (online: 10.06.2025).
Saeidizand, P., Fransen, K., & Boussauw, K. (2022). Revisiting car dependency: A worldwide analysis of car travel in global metropolitan areas. *Cities*, *120*. https://doi.org/10.1016/j.cities.2021.103467
Shahriari, S., Siripanich, A., & Rashidi, T. (2024). Estimating the impact of cycling infrastructure improvements on usage: A spatial difference-in-differences approach. *Journal of Transport Geography*, *121*, 104012. https://doi.org/10.1016/j.jtrangeo.2024.104012
Staten Vegvesen (n.d.). Den Nasjonale Reisevaneundersøkelsen. https://www.vegvesen.no/fag/fokusomrader/nasjonal-transportplan/den-nasjonale-reisevaneundersokelsen/reisevaner-20242/ (online: 16.05.2025).
Stavanger Kommune (n.d.-a). *Klimakontrakten*. https://www.stavanger.kommune.no/klimastavanger/klimanoytral-by/klimakontrakten/ (online: 16.05.2025).
Stavanger Kommune. (n.d.-b). *Stavanger på sykkel*. https://www.stavanger.kommune.no/vei-og-trafikk/stavanger-pa-sykkel/ (online: 16.05.2025).

Stavanger Kommune. (2024) *Sykkelundersøkelser og statistikk*. https://www.stavanger.kommune.no/vei-og-trafikk/stavanger-pa-sykkel/sykkelstatistikk/ (online: 16.05.2025).

Strange, T., & Bayley, A. (2008). OECD Insights Sustainable Development Linking Economy, Society, Environment: Linking Economy, Society, Environment. OECD Publishing.

Szmelter-Jarosz, A., Chmiel, B., & Nozari, H. (2023). The mobility choices in Poland: is there a chance to transition from owned cars to a shared ones? *European Journal of Transformation Studies*, *11*(1).

Useche, S. A., Alonso, F., Boyko, A., Buyvol, P., Castañeda, I.D., Cendales, B., Cervantes, A., Echiburu, T., Faus, M., Gene-Morales, J., Gnap, J., Gonzalez, V., Ibrahim, M.K.A., Janstrup, K.H., Makarova, I., Mikusova, M., Møller, M., O'Hern, S., Orozco-Fontalvo, M., McIlroy, R.C. (2024). Yes, size does matter (for cycling safety)! Comparing behavioral and safety outcomes in S, M, L, and XL cities from 18 countries. *Journal of Transport Geography*, *114*. https://doi.org/10.1016/j.jtrangeo.2023.103754

Urbanek, A. (2021). Potential of modal shift from private cars to public transport: A survey on the commuters' attitudes and willingness to switch – A case study of Silesia Province, Poland. *Research in Transportation Economics*, *85*. https://doi.org/10.1016/j.retrec.2020.101008

Urry, J. (2004). The 'System' of Automobility. *Theory, Culture & Society*, *21*(4–5), 25–39. https://doi.org/10.1177/0263276404046059

Urząd Miasta Krakowa (UMK). (2005). *Strategia Rozwoju Krakowa*. https://strategia.krakow.pl/252788,artykul,strategia-rozwoju-krakowa.html (online: 16.05.2025).

Urząd Miasta Krakowa (UMK). (2021). *Polityka zrównoważonej turystyki Krakowa na lata 2021–2028*. https://www.bip.krakow.pl/?sub_dok_id=20667&bip_id=1 (online: 17.05.2025).

Urząd Miasta Krakowa (UMK). (2024). *Zajmą się rozwojem infrastruktury rowerowej w Krakowie – Oficjalny serwis miejski – Magiczny Kraków*. https://www.krakow.pl/aktualnosci/285201,26,komunikat,zajma_sie_rozwojem_infrastruktury_rowerowej_w_krakowie.html (online: 22.05.2025).

Urząd Miasta Krakowa (UMK). (2025). *Rowerem do pracy*. https://roweremdopracy.um.krakow.pl/campaign-editions/4 (online: 16.05.2025).

Włodarek, P., & Olszewski, P. (2020). Traffic safety on cycle track crossings–traffic conflict technique. *Journal of Transportation Safety and Security*, *12*(1), 194–209. https://doi.org/10.1080/19439962.2019.1622615

Wolf, S., Teitge, J., Mielke, J., Schütze, F., & Jaeger, C. (2021). The European Green Deal — More Than Climate Neutrality. *Intereconomics*, 56(2), 99––107. https://doi.org/10.1007/s10272-021-0963-z

Wolniak, R., & Turoń, K. (2025). The model of relationships between benefits of bike-sharing and infrastructure assessment on example of the Silesian Region in Poland. *Applied System Innovation*, *8*(2), 54. https://doi.org/10.3390/asi8020054

Wołek, M. (2018). Sustainable Mobility Planning in Poland. *Research Journal of The University of Gdańsk; Transport Economics and Logistics*, *76*. http://dx.doi.org/10.26881/etil.2018.76.01

World Commission on Environment and Development (WCED). (1987). *Report of the World Commission on Environment and Development: Our common future* (UN Doc. A/42/427). United Nations. https://digitallibrary.un.org/record/139811 (online: 27.06.2025).

Yanatma, S. (2023). *Cycling in Europe: Which countries and cities are the most and least bicycle-friendly?* https://www.euronews.com/next/2023/09/19/cycling-in-europe-which-countries-and-cities-are-the-most-and-least-bicycle-friendly (online: 16.05.2025).

Ziegler, R. (2016). Climate Neutrality – Towards an Ethical Conception of Climate Neutrality. *Ethics, Policy & Environment*, *19*(3), 256–272. https://doi.org/10.1080/21550085.2016.1226241