
Cyclist-Centered Design: Creating a “City of Cyclists” using Human-Centered Design

Michael Hohl

vcs260@alumni.ku.dk

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Introduction

Copenhagen leads the world when it comes to cycling. There are more bikes than citizens in Copenhagen. On the busiest streets, 20,000 cyclists pass by in either direction every day. (McClintock, 2002) Copenhagen residents make 63% of their commutes on a bike, and the number of cyclists has been rising since the 1970s. (Nielsen, Skov-Petersen, & Agervig Carstensen, 2013) The self-proclaimed “city of cyclists” has earned itself a reputation as a cycling leader, and biking has become a part of Copenhageners’ culture and identity.

How did this occur? Do Danes, who are also leaders in renewable energy, bike to combat climate change? Do they just love biking? Survey results from Copenhagen bicyclists suggest otherwise. Haven’t the Danes always been bikers? The history textbooks tell a different story. Careful analysis and research reveals that Copenhagen’s status as a biking leader did not come about as a result of individuals’ motivation to bike, nor by means of any single motivating factor, but instead as the result of several structural factors, such as political, economic, and historical forces, that, combined with a massive push from Copenhagen city planners, turned the city into the biking leader that it is today. Together, urban designers, architects, city planners, economists, policymakers, and government officials collaborated to successfully promote biking. Furthermore, the city’s efforts to promote cycling have been based in a human-centered and participatory design approach that has contributed to its success.

Discussion

Design Approaches

Throughout history and still today, architecture and urban planning have mostly been top-down disciplines. This means that designers (and public officials) alone make the decisions. It makes for an efficient approach to public planning that is systematic, rational, and allows for standardization.

In contrast to top-down design, participatory and communicative planning, which involve elements of a bottom-up approach, have sparked interest in the past couple decades. As defined by Karel Martens, communicative planning involves all stakeholders in the decision-making process, including everyday citizens, rather than just the designer. Some scholars argue that including stakeholders in the planning process is the most crucial element for the success of urban planning. The use of participatory planning has several advantages. For example, resident participation raises the level of acceptance of urban planning decisions. Local residents also have expert knowledge of the area, which, when combined with the designer's expert knowledge, can make for a better final design. Additionally, participation can build trust and raise user satisfaction. (Kagu, Anu)

Jan Gehl, a leader in the movement to create livable cities, has written extensively about the "human dimension". He writes that city and traffic planners have failed to prioritize city life and that there was little understanding of how physical structures influence human behavior. As a result, cities became filled with noise, pollution, limited space, and threats to safety. These problems became exacerbated by ideologies of

modernism, which emphasized a narrowly-focused view of individual buildings rather than a holistic approach that considers the common spaces and interrelations between structures. Now, cities have a wealth of knowledge on that relationship between behavior and physical structure, and more populations demand inclusion in the planning of urban spaces. This leads to participatory design, which integrates user input into design decisions.

Human-centered design takes a similar approach to the design process as participatory design and bottom-up design because it emphasizes peoples' natural needs and behaviors. IDEO, a leading design firm, defines human-centered design as a process that "starts with people, and ends with innovative solutions tailored to meet their needs." (Norman, 1988) Although "human-centered design" is a term often used within the realm of product design, and "participatory design" is a term often used in the context of urban planning, their core tenets are quite similar. In the essay that follows, the terms are used somewhat interchangeably, as the two phrases both refer to a design process grounded in an understanding of users' needs and behaviors. Human-centered design and participatory design principles have contributed to the success of Copenhagen in creating a "city of cyclists".

Historical Background

To understand Copenhagen's development into cycling city, one must first examine its historical roots, which reveals that the use of bikes versus the use of cars depended largely upon the availability and affordability of cars. Furthermore, Copenhagen's longstanding tradition of bike riding helped establish the framework that

has allowed modern city planners to more easily develop biking infrastructure. Prior to the mass production of cars in the 1920s, biking was the main mode of transportation throughout Europe. (Gössling, 2013) Dating back to the late 19th century, Copenhagen had a thriving biking culture. It wasn't until the 1950s when cars became widely available to consumers. Prior to this, during what scholars have called the "Golden Age" of biking, cycling became a means of mass transit. However, that started to change after World War II. During the war, Denmark had introduced rationing policies that restricted the use of oil, fuel, and rubber. These policies helped fuel the "Golden Age" of biking, but once these rationing policies were removed, biking began to decline rapidly as cars became affordable and popular throughout industrialized nations. On a global scale, the average distance biked per person fell from 1400km per year to 1000km per year. At the same time, car usage increased. While in the 1910s streets were virtually car-free, the global average rose to 2000 km per person per year. (Gössling & Choi, 2015) This decline in the use of bikes and the simultaneous increase in the use of cars exemplifies how political factors (like rations) and economic affordances (like cheaper cars) affected peoples' choices to bike or drive. In the 1970s, Copenhagen had planned to begin many car-oriented infrastructural projects, but an oil crisis and an economic recession forced city planners to cancel the projects. As a result, citizens demanded improved cycling conditions in the 1980s. (Gössling & Choi, 2015) This oil crisis and recession demonstrate how unforeseen economic factors played a role in limiting car use (and thereby promoting cycling), while the citizens' demonstrations highlighted the role of the Copenhagen people in promoting cycling. Prior to the widespread use of cars, Copenhagen's long held tradition of biking meant that an extensive network of biking

paths already existed. In fact, much of that biking infrastructure still stands today, and half of the city's current cycling infrastructure predates the 1970s. (Gössling & Choi, 2015) The existence of such a network of bike paths meant that modern city planners didn't have to start from the ground up — they already had an advantageous starting point, especially compared to other countries that would have had to spend much more money to develop cycling infrastructure. Indeed, many cities confront challenges in implementing new transport systems due to financial limitations. (Hutton, 2013) Those old bike paths literally paved the way for modern city planners to justify additional investment in the promotion of bike riding and creation of biking infrastructure. By examining Copenhagen's history, we find evidence that peoples' choices to bike or drive are affected by economic and political factors, and that the older biking infrastructure lowered the economic burden of turning the city into its modern cycling powerhouse.

Urban Designers & City Planners

Copenhagen owes much of its success in biking to the efforts of recent city planners, who have made a huge push for the promotion of biking throughout the city. The municipality of Copenhagen created its first biking strategic plan in 2002, which marked the first of several strategic plans. The publication outlined a vision of development plans that would promote cycling. Shortly after, the city made additional plans, such as the Bicycle Track Priority Plan. Additionally, a bi-annual publication called Bicycle Accounts monitored newly established success metrics and key performance indicators, as well as surveyed bikers on their opinions and experiences. In 2007, the city declared its goal to become “the world's best city for cyclists.” (Gössling

& Choi, 2015). Most importantly, these plans outlined a process that would take a human-centered (or in this case, cyclist-centered) design approach. This meant understanding and prioritizing the needs of cyclists throughout the process of designing and implementing biking infrastructure. Using this approach meant surveying cyclists, collecting cyclists' input, collecting data on cyclists' behaviors to measure intervention success, and embracing a mindset of innovation and experimentation. This cyclist-centered approach has contributed to Copenhagen's success in biking and guided city planners' efforts as they built cycling infrastructure and projects.

City planners' decision to pursue the creation of a "city of cyclists" stems partially from environmental and health concerns, but ultimately comes from economic considerations that also take these factors into account. Climate change and environmental concerns did partially motivate the decision by Copenhagen city planners to promote biking. Biking does not pollute, whereas cars cause air pollution by releasing harmful CO₂ into the atmosphere. Public transportation, too, requires energy and releases pollution, although the amount of pollution per person is considerably much less. So, the creation of cycling infrastructure is part of the city's goal of becoming a leading "eco-metropolis" as well. In order to do this, the city has used environmental economics in their decision-making process. (City of Copenhagen, 2012a, 2012b) This led to the creation of a cost-benefit analysis framework that the city uses to determine economic benefit or loss of a proposed project.

To be sure, the city planners' decision to promote cycling was made as the result of several factors, but economic factors carried the most influence. Basic economic theory stipulates that in order to make a decision about whether or not to spend money on

something (like a smørrebrød or a plan to design a city-wide network of bike tracks) the deciding person or entity must conduct a cost-benefit analysis, or CBA. So, Danish economists conducted a CBA for both driving and biking that included the costs associated with accidents, health, recreational value, travel time, and climate change. The analysis revealed that every kilometer driven or biked incurs a cost to society, but that biking has a cost six times less than that of driving. Specifically, economists determined that driving costs .50 euros per kilometer driven, and biking cost only .08 euros per kilometer driven. (Gössling & Choi, 2015) The city also conducts a CBA when deciding whether or not to invest in the creation of a cycling infrastructure project by quantifying the costs and payoffs associated with the project (such as the cost of building it and the payoff in terms of time saved for cyclists). This CBA is based on the factors such as transportation time, costs, comfort, security, health, and branding effects & tourism. (City of Copenhagen, 2009a) Evidence shows that the CBA system Copenhagen uses convincingly demonstrates that investments in bicycle infrastructure, safety, and bike-promoting policies yield a high return on investment, justifying the economic costs. (Gössling & Choi, 2015) This CBA serves as an effective economic tool that guides the city's investment choices when considering new biking infrastructure projects.

Infrastructural Improvements

The city of Copenhagen has completed hundreds of infrastructural projects that have improved the viability of biking. Projects include cycle tracks that separate cyclists from traffic with a curb, short-term rental bikes, allowing bike transportation on rail cars (sometimes with onboard racks for bikes and at no extra cost on the S-train), car-free

zones, traffic calming (traffic controls), techniques to shorten cyclists' routes, wayfinding signage, maintenance of infrastructure, increasing the width of cycling paths, sweeping bike paths, bicycle traffic signals, bike boxes (or 'advanced stop lights'), shared lane markings, colored bike lanes, bike boulevards, off-street paths, signaled bicycle routes, on-road bicycle lanes, two-way travel on one-way streets, and showers at workplaces. A meta-review of 139 studies suggests that all these projects have had positive results on the level of biking in Copenhagen. (Gössling and Choi) Additional infrastructural projects include strategically located bicycle bridges over water or car roadways, which have added incredible accessibility to biking. Furthermore, small details do not get overlooked — footrests have been installed at intersections and people place garbage bins away from cyclists. Safety constitutes another priority for cyclists and city planners, so urban planners have redesigned intersections to make them safer. To deal with snowy conditions, the city created a policy that ensures the removal of snow from bike tracks before the removal of snow from car lanes. Biking comes first. In general, increasing the connectivity and quality of the network of biking paths has been a high priority for Copenhagen city planners. Today, over 350 kilometers of bicycle paths exist, 43 kilometers of which are the "green wave" bike paths. (Nielsen et al., 2013) Copenhagen's determination to become a cycling city is evident in the sheer number of infrastructural projects that the city has completed. However, it's crucial to note that urban planners did not simply create an infrastructure that they alone thought would serve the city best. They consulted with their users to inform their decisions.

User Research: Guiding Infrastructure Development with User Data

Most Copenhageners are not motivated to bike out of a love of biking or because they find it enjoyable. A well-done human-centered design process requires understanding the motivations, goals, and frustrations of the target audience so that (urban) designers (and city planners) can help people accomplish their goals. In a quintessentially human-centered approach, the city consults with both stakeholders and users regarding cycling conditions. (Nielsen et al., 2013) Copenhagen identified cyclists' motivations for biking through the bi-annual Bicycle Accounts survey. They found that 55% of survey respondents chose "it is faster" as a reason they choose to bike, making it the most important factor influencing peoples' decision to bike. It was followed by "more convenient" at 33%, "healthy" at 32%, "cheap" at 29%, "makes me feel good" at 26%, and "a good way to start the day" at 21%. Interestingly, climate change was hardly reported as a motivating factor in cyclists' decision to bike. (Gössling & Choi, 2015) In fact, when asked for the main reason they choose to bike, only 1% of Copenhageners selected "Environmental concerns". Importantly, because they've conducted surveys like this, city planners know peoples' motivations for biking. In an interview, Marie Kåstrup demonstrated her understanding of cyclists' motivations by saying that "People don't feel like saving the world when cycling to work in the morning, they just want to get to work. That is why cycling should be convenient and easy. We try not to make cycling overly complicated." In addition to studying cyclists' motivations, the Bikeability research project has found that nearby connections to public transport or good walking options have a negative effect on the number of cyclists. (Rask, 2013) Additionally, leisure-oriented bike trips constitute less than 10% of trips. Instead, the vast majority of cyclists bike as a means of transport between destinations. These research findings highlight the

fact that the enjoyment of bike riding does not play a leading role in cyclists' decision to bike. Practicality motivates Copenhageners to bike. Thus, urban designers and city planners bear the onus of making cycling the most practical option.

Copenhagen also uses the feedback it receives in the Bicycle Account survey and software tools to guide their infrastructural improvements. For example, in 2000, the survey results showed that 48% of cyclists find Copenhagen "good" or "excellent" for biking, but that a much smaller percentage of people felt satisfied with the maintenance of cycle tracks. City planners took this feedback into account by raising the budget for cycle track maintenance to DKK 9.1 million. (McClintock, 2002) A smartphone app also helps the city collect feedback. The app allows cyclists to suggest improvements for cycling tracks and cycling lanes, essentially crowdsourcing data from cyclists for city planners to identify problems. The app conveniently uses the cyclist's GPS location to add their suggestion onto a map. The corresponding website "Tip Us Off" has a similar function. The website alone collected over 1000 suggestions for improvement in a period of fewer than 2 years (ending in December 2012). The city actually finished implementing 393 of those suggestions, had begun implementing 52 of them, and had another 82 scheduled to take place as of 2013. (The city stated that they could not fix the remaining suggestions under the scheme of the website/app.) (Gössling, 2013) In addition to the tangible infrastructural changes that the app/website result in, they invite cyclists to take an active role in shaping the cycling city that they want, reinforcing cyclist identities. These simple examples demonstrate how the city responded to user feedback in order to meet cyclists' needs with a participatory approach to design.

Studying bicyclist behavior has lent itself to insights that guide the creation of

biking infrastructure in Copenhagen. One example is the Bikeability research project, which, among other methods, used GPS to track cyclists' routes. By analyzing cyclists' GPS data, they found that cyclists would rather turn right than left, and that they would (on average) prefer to take an 85m detour in order to circumvent a left turn. Similarly, they would rather go straight than right, and would prefer to take a 50m detour in order to avoid a right turn. They also confirmed that bikers preferred cycling an extra 1.7km in order to ride along a bike track. To avoid frequent stops at traffic lights and crowded bike tracks, cyclists will usually add an extra .4 kilometers to their ride. Finally, they found that the average ride spans 5.4 kilometers with an average speed of 14.4kph. (Rask, 2013)

Collecting this data on cyclists' behavior has helped city planners model cyclist behavior when considering bike path proposals and has allowed them to make data-driven design decisions, as exemplified by the "green wave" bike lanes. These special bike lanes, which span heavily trafficked streets, time the stoplights to coordinate with bicycles' speeds rather than cars' speeds. Knowing the average speed from the GPS data, they timed the lights so that cyclists traveling at 20 kph will hit only green lights without having to stop at a red one. (Linholm, n.d.) It encourages some cyclists to go faster, but it also causes fast cyclists to decrease their speed, creating a safer environment for everyone. (Note that if the timing of the lights accommodated the actual average cycling speed (14.4 kph), the fast cyclists might actually increase their speed to move twice as fast as other cyclists, which would create a more dangerous environment). Most importantly, the green wave saves cyclists time and makes their ride more convenient, which (as city planners learned from surveying cyclists) motivate cyclists to ride more than any other factors. The green wave project exemplifies how city planners can promote biking by using a human-

centered design approach based on studying the motivations and behaviors of cyclists.

Thanks to the research on cyclist motivations, city planners know that if they want to encourage biking, they have the responsibility to make biking the fastest and most convenient option. So, biking infrastructure had to be built. One project, a bridge called Cykelslangen (or “Cycle Snake”) has received much recognition. Cykelslangen creates a bike path elevated 7m above pedestrians to relieve congestion and shorten bike trips. Prior to the creation of Cykelslangen, cyclists had to lug their bikes up stairs and bike through a harbor-front shopping area where pedestrians and shoppers saunter, requiring cyclists to slow down, turn, and accelerate as they dodged pedestrians — Cykelslangen fixes these pain points. (George, 2014) Two of Copenhagen’s strategic goals stipulate reducing cyclist commute times by 15% and allowing 90% of cyclists to feel safe in traffic by 2025. The bridge, as part of this city initiative, provides safety and accessibility by removing cyclists from pedestrians, traffic, and staircases. (Frandsen, 2016) Also, as city planners learned from surveying bikers, saving time and convenience are bikers’ top motivations for biking — Cykelslangen is an urban design solution that addresses both those factors and creates a shortcut. Copenhagen urban designers are able to promote biking because they have studied the motivations of the people they’re designing for, allowing them to prioritize projects that align with cyclists’ desires.

Super Cycle Highway: Target Audience/Personas

Copenhagen has also used another method that human-centered design utilizes: the identification of personas. Personas are similar to what a marketer might call “target audiences”. Personas have specific needs (identified through user research) tied to their

identities. The Super Cycle Highways project exemplifies a cycling infrastructure project designed for a specific persona: people commuting between 5 and 20 km from the Capital Region. The project aimed to introduce high quality bicycle paths independently of municipal boundaries, making biking more accessible and safe. As of 2015, the city had planned 26 routes and had built several. The project centered upon several goals. Accessibility marked the top priority, which meant that the network of bike paths attempted to act as a natural link between common commuter destinations like the workplace, home, school/university, and public transportation terminals. Secondly, the paths focused on optimal routes that ensured the shortest travel time between destinations. Thirdly, urban planners prioritized the comfort of the cycling experience by incorporating service stations with bike tools, bike-specific traffic lights, and footrests at intersections so that cyclists do not have to dismount their bikes. This massive project has required the cooperation and coordination of 22 metropolitan municipalities and the Capital Region, (Ingstrup, 2015) which demonstrates how incredible projects can arise when urban planners work across boundaries to address cyclists' needs together. Furthermore, the Super Cycle Highways project shows yet another way Copenhagen has utilized human-centered design methods like personas to guide their approach in the promotion of biking.

Prototyping and Innovation + Bike Sharing

Copenhagen city planners have also embraced another core tenet of human-centered: the notion of innovative prototyping. Prototyping is a design approach that relies on users' responses to designs in order to assess the design's usefulness. If a

prototype is found to be beneficial, designers have learned that it works. If users don't like the design or it's found to be impractical, the idea is scrapped or improved upon in a redesigned prototype. Essentially, the concept is to rapidly test out an idea and get user feedback in order to see if a design will work. Most importantly, it requires the boldness to do something new and different. Copenhagen has done this in a few projects. For example, it has "experimented with bicycle "fast lanes" at high-traffic areas". (Nielsen et al., 2013) The city has also tried out using LED sensors that warn truck drivers of oncoming bikers at high-risk intersections. City planners also implemented some service-based initiatives like the "karma campaign", which rewarded bikers with chocolate for appropriate cycling behavior, and another initiative that put "bike butlers" at 5 metro stations to pump tires and lubricate chains. (Gössling, 2013) Although not all of these "prototypes" exist today, others have paved the way for highly successful programs. These "prototypes" demonstrate Copenhagen's willingness to experiment with innovative out-of-the-box ideas by using a prototyping mindset that contributes to their success in promoting cycling.

A history of bike sharing programs exemplifies Copenhagen's willingness to launch novel projects, learn from mistakes, and apply those learned lessons towards an innovative solution. The first modern example of a bike-sharing program comes, not from Copenhagen, but from Amsterdam. In 1965, the White Bikes Plan began. An industrial designer and politician named Luud Schimmelpennink and his colleagues gathered hundreds of bicycles, painted them white, and made them publicly available for free use. However, the plan failed as people rode them outside of the city, stole them for their own use, disassembled them for parts, or threw them into canals. The next significant step

forward came with Copenhagen's City Bikes initiative, which offered bikes for free and generated huge publicity for the city. The designers of the City Bikes focused on utilitarianism. Bikes had advertising plates to defray the cost and solid rubber tires to prevent flat tires. The bikes could be rented with a coin deposit at one of several stations in the city center. (Metrobike & DeMaio, n.d.) However, the program had several shortcomings. Observing the problem of theft in Amsterdam's White Bikes Plan, bikes consisted of non-standard materials to deter the theft of bike parts. Although this helped, due to the anonymity of cyclists, theft of bikes still hindered the program. Additionally, the heavy and hard rubber tires made them unenjoyable to ride, and they lacked both lights and luggage carriers. (McClintock, 2002) Copenhagen's newest bike-sharing program, which launched in 2014, learned from the mistakes of these previous attempts at bike sharing to create an improved system, which, after a poor start, has become widely popular. Once again, the city identified a "persona", or target audience: tourists. Since the vast majority of Copenhageners have access to a bike (and therefore would be less likely to use a bike-sharing bike), planners designed the "GoBikes" with tourists in mind. The program's bikes come equipped with electric motors, mounted electronic tablets, air-inflated tires, lights, and luggage racks. Specific design features serve tourists particularly well. The electric motor aids foreigners who might not be accustomed to cycling by allowing them to go further than they could on their own stamina. The tablets come loaded with mapping software that helps riders navigate unfamiliar territory. The system encourages riders to return their bikes to specific stations by offering reduced prices on future rides, helping to ease the city's burden of constantly redistributing bikes. This time around, there have been relatively few attempts of theft or

vandalism. (Mirani, 2014)The current “GoBikes” bike-sharing system owes its success in part to the lessons learned from previous bike-sharing systems and the identification of a persona (tourists) that influenced the design. For example, the anonymity of led to theft in previous bike-sharing initiatives. So, this new system requires making a user account linked to a credit card before using a bike, mitigating attempts of theft. Additional improvements in design features, such as electric motors, targeted the specific needs of tourists. Copenhagen has launched this successful bike-sharing program due to its identification of a target persona and its study of previous versions (or “prototypes”) of bike-sharing systems that shaped this system’s design.

When Copenhagen Fails to Use a Human-Centered Approach...

Copenhagen’s success owes its success in cycling partly due to its adherence to participatory and human-centered design principles. However, the city is by no means infallible, and when Copenhagen has failed to use a human-centered result, the results become less effective. The new inner harbor bike bridge, Inderhavnsbro, has had more than 15,000 cyclists cross it in a single day, and the number of people crossing it is proof of that the bridge serves as a crucial artery in that location. The bridge fulfills its primary function by allowing cyclists and pedestrians to cross the body of water, but it has shortcomings. Firstly, the bridge inclines quite steeply, making it difficult for the 40,000 heavy cargo bikes in Copenhagen or weaker cyclists, ultimately forcing some to get off their bike and walk. (Colville-Andersen, 2017) Designers could have avoided this problem with a number of different designs. However, more importantly, if the designer had done their user research, they would have foreseen this problem. Denmark pioneered

the research of cyclist behaviors in the 1930s. In order to determine when a hill was too steep, Danish researchers did field work observing how many cyclists got off their bikes and began walking at various levels of incline. (Schønberg, 2012) If the designers had consulted this research, the bridge could have catered to a wider range of cyclists. The skid marks near the sharp turns, or chicanes, highlight another design flaw of the bridge. As cyclists gain speed going down the steep incline, the bridge requires them to make a sharp turn instead of continuing straight (or else they would hit a panel of glass). The skid marks near the sharp turns on either end indicate that many cyclists have almost collided with the glass. One glass panel has already been shattered (although this may not have resulted from someone biking into it). Seeking to address this problem, the city stuck high-contrast white and red warning adhesives onto the glass to make the glass more visible. (Colville-Andersen, 2017) Human-centered design thinkers like Don Norman argue that if a design has needed the addition of a label or warning, then it demonstrates bad design. (Norman, Don. Colville-Andersen, 2017) Best practice standards for chicanes have existed for decades, and evidence has shown that curvature (rather than sharp turns) offers better safety and comfort. Thus, both of the problems with the bridge demonstrate that problems arise when designers ignore human-centered design principles like user research.

Beyond Urban Designers: Policy, Economics, and Private Business

The efforts to turn the city into a "city of cyclists" expands beyond the role of the urban planners alone, including a wide variety of roles taken by lawmakers and the government. For example, in 1948, the Danish parliament passed a law to address bike

theft. The law requires that all bike sold and transferred within Denmark get stamped with a registration ID number. These numbers help with the identification of stolen bikes, and can aid in obtaining compensation from insurance companies given that the bike had been locked to the bike's frame with an approved lock. (FritznerSara, n.d.)

Undoubtedly, Copenhagen urban designers have made tremendous progress in their efforts to promote cycling, however, it's crucial to understand that the adoption of biking did not occur as an isolated phenomena; in order to promote biking, other means of transportation, namely cars, have gotten deprioritized and even discouraged through infrastructural changes and economic policies and incentives. Jan Gehl convincingly argues that fewer roadways for cars cause a decrease in the number of cars on the road. San Francisco's 1989 earthquake created the perfect natural experiment to test this idea. The earthquake destroyed the Embarcadero roadway, a main thoroughfare for cars with a double-decker highway, rendering it unusable. Though before the roadway got reconstructed, it grew evident that the city did not need it. Citizens had adapted their transportation habits to the new situation. Removing roadways has reduced the number of cars on the road in other cities, too, like in Seoul, Milwaukee, and Portland. (Gehl, 2010) Copenhagen, also, has had success in reducing the number of cars on the roadway by removing car infrastructure. On key bike arteries, road space for cars has given way to increased space to bicycles. For example, city planners deliberately reduced the number of parking spaces available in the city center in order to discourage car usage by making it less convenient. (Nielsen et al., 2013)

In addition to a reduction in car infrastructure, economic policies such as sales taxes on new car purchases and petrol, drivers license fees, higher parking fees, driver

training fees, import tariffs, and registration fees that increase the financial burden of car ownership. And, in a broader perspective, European economic policies make car useage and ownership 2 to 3 times more expensive than in the United States. (Pucher & Buehler, 2008) These measures have been shown as effective in significantly reducing car usage growth rates. (Gössling, 2013) Other policies include fuel efficiency standards, high occupancy vehicle (HOV) lanes, and speed limits, which are used to support alternative transportation choices. (Gössling, 2013) The success of these policies, both infrastructural and economic, demonstrates that both “pull” and “push” methods combine to be highly effective in nudging Copenhageners’ towards choosing alternative and cheaper transportation options like cycling by making driving a less convenient option.

Aside from command-and-control policies, Copenhagen has also attempted to discourage the use of single car occupancy and car ownership by using and funding soft-policy initiatives. These soft-policy measures use education and information as a means of promoting sustainable means of transport. They include a wide range of instruments, such as information and marketing campaigns, car-sharing initiatives, software tools such as video conferencing, shopping from home, car co-operatives, and smartphone apps such as Rejseplanen (which helps users use Copenhagen public transportation to navigate to their destination). Such measures seem to have had success in affecting transport behavior (Gössling, 2013), but some additional studies cast skepticism on these results. (Cairns et al., 2008) Furthermore, initiatives such as individualized marketing, and bike-to-work days seem to have had more limited effects on bicycling than infrastructural changes. Some scholars conclude that where such measures did in fact have significant results, growth in biking was less than growth in walking and public transportation.

(Pucher & Dijkstra, 2003)

Looking beyond the role of government and economic policy, one can observe that other factors, such as the role of private businesses, have fueled Copenhagen as a “city of cyclists”. Private businesses have added innovative cycling products to the marketplace that address cyclists’ needs and therefore promote a culture of biking. One such company is Reelight, which has developed a battery-free bike light that turns on whenever the wheels are moving. It relies on two magnets attached to the spokes of the wheel and an adjacent light attached at the bottom of the bike’s fork. As the wheel spins, the electromagnetic induction principle works to generate electricity for the light. This product improves upon other types of lights because it attaches to the bike (making it less likely to fall off), doesn’t rely on batteries that need to be replaced, doesn’t require cyclists to even remember to turn on the lights, and uses clean renewable energy. Additionally, a study by Odense Bicycle City reported that, in some cases, having fixed magnet lights reduces the number of accidents by 32 percent. The study also reported that fixed magnet lights could increase cyclists’ perception of safety by up 85 percent. (FritznerSara, n.d.) Reelight’s fixed bike light exemplifies a Danish company that has promoted the use of biking with a product that makes it safer and more convenient.

Other Danish companies, such as Yakkay, have also made cycling safer. Many cyclists do not wear helmets because of stylistic preferences. Hoping to solve this problem, Yakkay designed fashionable helmets that merge style and safety. A large cover or cap stretches across the outside of the helmet, which comes in many different designs and which wearers can easily take off and replace. Then, of course, Danish companies like Winther, Kildemoes, Principia, and Avenue manufacture large quantities of bikes

Smaller Danish businesses like Velorbis, Von Bachhaus, and Biomega also do custom bikes on a smaller scale. These companies make a variety of bicycles that fit cyclists' functional and stylistic needs. The notable cargo bike styles have a large presence in Copenhagen, with 25% of all families with two kids owning a one, and they demonstrate the utilitarian focus of cycling in the city. There are several Danish cargo bike companies, such as Christiania Bikes, Nihola, and Trio Bike. Cargo bikes come in a variety of styles, such as two-wheelers that are fast, and tricycles that have a larger cargo area and greater stability for heavier loads. The bikes can be used for hauling groceries, miscellaneous goods, and even small children. (Fritzner, Sara et al.) The adoption of cargo bikes and the benefits they provide demonstrate how bicycle have numerous functions that align with the needs of Copenhageners.

These companies, including Reelight, Yakkay, and bike manufacturers, assist in making Copenhagen the cycling city that it is today by making cycling safer, stylish, and more convenient — their success in business indicates that their products solve cyclists' needs and have promoted a culture of cycling.

Aside from product-oriented companies like these, the many architectural and engineering firms are hired by the city of Copenhagen, and as such, play an obvious role in making cycling the better option. Several of these companies have taken on projects mentioned above, such as the two bike bridges. Veksø architecture firm designs and manufactures cycling products and urban furniture. As the amount of cycling in Copenhagen increases, so does the demand for bike parking spots. Veksø has focused not only on the appearance and functionality of bike racks, but also on integrating bike racks into the environments so that they are unobtrusive and in harmony with the urban

landscape. The city also hired Veksø to install a digital bicyclist counter, which, in addition to collecting valuable data on cycling, also sends the message to cyclists that their choice to bike actually matters. (Fritzner, Sara et al.) Veksø exemplifies one of many companies that the city has hired in its efforts to promote biking. These types of companies play an important role in the creation of Copenhagen as a cycling city.

Although urban planners have made a huge push towards the creation of a “city of cyclists”, one can observe that other actors, such as policy makers, lawmakers, and private companies also play a role in Copenhagen’s success. To overlook these additional roles would give an incomplete explanation of Copenhagen’s cycling success.

Conclusion

Copenhagen has earned its title as the “City of Cyclists”. The city is a worldwide leader when it comes to cycling. How did it happen? Investigating the causes of Copenhagen’s evident bike culture reveals a few common themes. Firstly, Copenhagen could not have achieved its high levels of cycling without massive coordination across disciplines and boundaries. Evidence comes from successful infrastructure projects that span municipal boundaries and the roles played by urban planners, city leadership, architects, economists, policy makers, software developers, environmentalists, members of parliament, private businesses, and of course, the citizens who choose to bike. Secondly, Copenhagen’s high levels of cycling emerged as a result of a variety of factors, such as historical, political, economic, and cultural forces. These influenced city planners’ decision to promote cycling to begin with, which then acted to create additional changes that nudge Copenhageners towards choosing cycling on a daily-basis. Lastly, a key ingredient that led to the city’s success was its use of a design process that can only be characterized as “cyclist-centered”.

Bibliography

- Bottom-up, T. M., Futures, P., Ja, I. M., & Omaalgatus, K. (n.d.). No Title.
- Cairns, S., Sloman, L., Newson, C., Anable, J., Kirkbride, A., & Goodwin, P. (2008). Smarter Choices: Assessing the Potential to Achieve Traffic Reduction Using “Soft Measures.” *Transport Reviews*, 28(5), 593–618. <https://doi.org/10.1080/01441640801892504>
- City of Copenhagen, 2008. Eco-Metropolis. Our Vision for Copenhagen 2015. City of Copenhagen, Copenhagen.
- City of Copenhagen, 2012a. Københavns Miljøregnskab 2011 [Copenhagen's Environmental Balance Sheet].
- City of Copenhagen, 2012b. Københavns Miljøregnskab – samlet udgave (Copenhagen's Environmental Balance Sheet — Collected Issue).
- Colville-Andersen, M. (2017, April). Copenhagen’s Latest Piece of Cycle Infrastructure. *Arch Daily*.
- Frandsen, I. O. (2016, March). The Bicycle Snake. *Danish Architecture Center & Life*.
- Fritzner Sara. (n.d.). Danish Design and Innovation for Cyclist. *Denmark.dk*.
- Gehl, J. (2010). *Cities for People*. Washington: Island Press.
- George, A. (2014, July). Copenhagen’s New Bike Skyway Makes Commuting Look Fun. *WIRED*.
- Gössling, S. (2013). Urban transport transitions: Copenhagen, city of cyclists. *Journal of Transport Geography*, 33, 196–206. <https://doi.org/10.1016/j.jtrangeo.2013.10.013>
- Gössling, S., & Choi, A. S. (2015). Transport transitions in Copenhagen: Comparing the cost of cars and bicycles. *Ecological Economics*, 113, 106–113. <https://doi.org/10.1016/j.ecolecon.2015.03.006>
- Hutton, B. (2013). *Planning Sustainable Transport*. New York: Routledge.
- Ingstrup, J. (2015, June). Super Cycle Highways. *Danish Architecture Center & Life*.
- Linholm, L. (n.d.). Cycling in Copenhagen - The Easy Way. *Denmark.dk*.

- McClintock, H. (2002). *Planning for Cycling: Principles, Practice and Solutions for Urban Planners*. Boston: Woodhead Publishing.
- Metrobike, & DeMaio, P. (n.d.). Bike-sharing: History, Impacts, Models of Provision, and Future, (DeMaio 2004), 41–56. <https://doi.org/http://dx.doi.org/10.5038/2375-0901.12.4.3>
- Mirani, L. (2014, June). Meet the future of public transport: electric cycles with onboard tablets. *Quartz*.
- Nielsen, T. A. S., Skov-Petersen, H., & Agervig Carstensen, T. (2013). Urban planning practices for bikeable cities – the case of Copenhagen. *Urban Research & Practice*, 6(1), 110–115. <https://doi.org/10.1080/17535069.2013.765108>
- Norman, D. (1988). *The Design of Everyday Things*. New York: Basic Book.
- 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., & Dijkstra, L. (2003). Promoting Safe Walking and Cycling to Improve Public Health: Lessons from The Netherlands and Germany. *American Journal of Public Health*, 93(9), 1509–1516. <https://doi.org/10.1016/j.yjpm.2009.07.028>
- Rask, S. (2013). *Bikeability*. Retrieved from <http://www.cycling-embassy.dk/2013/06/05/bikeability-2/>
- Schønberg, M. (2012). Danish Bicycle Infrastructure History. *The Blog, by Copenhagen Design Co*.