

# The Current and Future State of Emission-Free Cargo Delivery

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# Abstract

In collaboration with Miljøpunkt Amager, our team assessed the feasibility of incorporating emission-free freight transportation into the delivery models of local businesses, with the primary focus being on the 2300 postal code of Copenhagen. Through comprehensive literature review, interviews, surveys, and qualitative analysis, our team gathered information related to delivery logistics and bike transportation. We determined that there are many steps local businesses can take to improve the sustainability of their freight transportation systems with minimal disruption to their business model. We hope that our findings contribute to Denmark's pursuit of carbon neutrality, and for future global sustainable delivery endeavors.

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# Executive Summary

## Background

In Copenhagen, Denmark, approximately 27 million tons of Greenhouse Gases (GHGs) were released into the atmosphere in 2020 alone (Ritchie & Roser, 2020). About 44% of these emissions came from the transportation sector (Tiseo, 2019). Freight traffic has an outsized environmental impact compared to other vehicles caused primarily by emission of many harmful pollutants, which can have devastating short-term and long-term effects on communities, including smog, health concerns, and long-term irreversible climate change (Union of Concerned Scientists, 2018). In Denmark, 45% of road transportation carbon emissions are produced by light or heavy duty vehicles, the category under which freight delivery vehicles are classified (Winther, 2020). In addition, the average light/heavy duty vehicle emits around seven times more particulate pollution than the average passenger car (Winther, 2020). Furthermore, these light/heavy transportation vehicles alone are responsible for a majority of mobility-related particulate emissions, despite being outnumbered by passenger cars 6:1 (Winther, 2020).

The “last mile”, the portion of delivery between a distribu-

tion center and storefront or storefront to customer, is one of the most critical points within the supply chain. This is the step where considerable changes need to be made. Our study focuses on the adoption of cargo bikes as a primary method for these deliveries. One of the benefits of using bikes for freight delivery is how they can decrease congestion in urban settings. Bikes have their own dedicated lanes and do not pose as large of an obstacle to each other while in motion like traditional vehicles. With proper infrastructure, bikes can pass each other and maneuver around each other much easier. Along with greenhouse gas reduction, bikes do not produce noise pollution or intense vibrations. One of the most beneficial effects of switching to cargo bike delivery in urban areas is that there are no exhaust emissions, which can have a “direct impact on improving air quality in the city” of Copenhagen (Nürnberg, 2019).

## Findings

Despite the existence of well-funded bicycle infrastructure, many stores receive freight through unsustainable and high

emission delivery services such as PostNord, DHL, or GLS. The majority of these deliveries are completed on their diesel fleets of vans. In our team’s investigation into six small businesses, three out of six small businesses reported receiving shipments solely through diesel vans, two of which on a regular schedule of at least once a week. Only one business was almost entirely without diesel deliveries.

Two businesses that were interviewed that tended to opt for more sustainable methods often serviced deliveries themselves. One storefront made the majority of the deliveries for their main products using a shared car. Other products were brought in either once a month or once a year on traditional diesel delivery vans. A second store had daily bike deliveries for fresh baked goods, and would handle acquiring and transporting coffee beans themselves. In both cases, their primary products were often locally sourced and self-managed.

Transitions to bicycle-based delivery systems are being halted by the values and necessities of business owners. We found through our research that businesses often favor punctuality and speed over sustainability. This provided a substantial barrier in the transition to sustainable delivery methods. One study conducted by Miljøpunkt Indre By & Christianshavn and Aalborg University found that “a low CO<sub>2</sub> footprint is considered a medium important quality” from a survey of 100+ companies in Copenhagen (Bohr et al., 2021). The study found that punctuality, flexibility, and delivery speeds far outweighed any ecological concern (Bohr et al., 2021).

Another barrier to the adoption of sustainable freight de-

livery noted by one sustainable delivery service is the common misconception of the capabilities of bicycle-based delivery. Businesses consistently underestimate the capability of cargo bikes. Two-thirds of the businesses our team interviewed believed that it was impossible for cargo bikes to fulfill their delivery needs. One business cited the size of their shipments, and another cited the weight. However, based on our discussion with bicycle-based delivery services, three of the four businesses that believed their goods were unsuitable for bicycle-based delivery could have their delivery needs met entirely by cargo bikes. The remaining business could be partially served.

## Recommendations

We recommend a tiered approach, shown in Figure 1, for small businesses. This multi-level approach allows small business owners to take reasonable steps towards sustainable delivery systems based on their personal values, resources, and business models. This approach layers solutions in a way that allows a business owner to consider their own delivery needs and find a tier that is a reasonable step to reduce their delivery emissions.

We also recommend Miljøpunkt Amager, an environmental organization we collaborated with, to publicize a variety of cargo bike delivery information. This can combat misconceptions about what can truly be accomplished by cargo bike delivery. Our team recommends publicizing our tiered proposal so that each business can cater solutions to their own business model.

This publication will dissipate any preconceived notions about cargo bikes that hinder sustainable transitions in their delivery methods.

Finally, we recommend that the Copenhagen Municipality create incentives targeted to small businesses who transition to sustainable delivery methods for their products. Investments by the municipality to reward businesses that perform bike deliveries or for small businesses that do deliver sustainably would result in increased transition to alternative delivery forms. This would then decrease congestion in Amager and therefore decrease emissions from heavy diesel trucks. This would also allow Copenhagen to make strides towards their climate goals to be carbon neutral by 2025.

## TIERED APPROACH

- **1. HIRE A CARGO BIKE SERVICE**  
Investigate the feasibility of hiring a cargo-bike service to warehouse and deliver a company's product.
- **2. INVEST IN A CARGO BIKE**  
Investing in a designated cargo bike for the small business that allows employees to make deliveries themselves.
- **3. USE PERSONAL BIKES**  
If the usage of a personal bike to make small deliveries is possible, it is highly encouraged!
- **4. LIMIT VEHICLE USAGE**  
Limit vehicle usage for deliveries in any way possible. This could involve using a personal car instead of a large diesel-based delivery service or sharing a car with neighboring businesses.

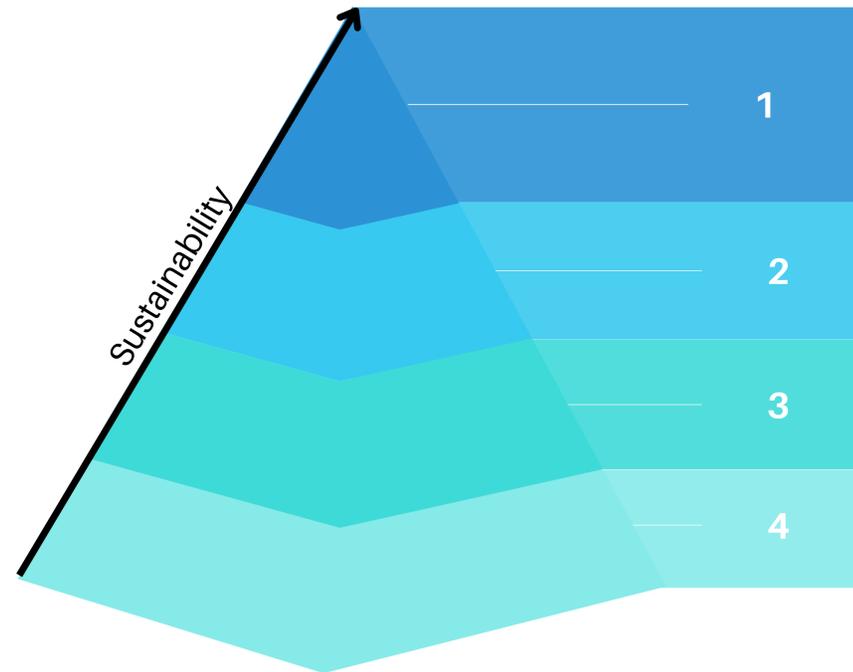


Figure 1: Tiered approach for small businesses implementing sustainable delivery.

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# Chapter 1

## Introduction

According to the United Nations (UN), climate change refers to the long-term shifts in temperature and weather patterns experienced in every community throughout the world (United Nations, n.d.). While this phenomenon could be a natural, unavoidable occurrence, human activities have been the main cause of climate change since the industrial revolution (late 1700s, early 1800s) (United Nations, n.d.). As we approach almost two and a half centuries of mass unsustainable practices, we find ourselves facing a dire global emergency that impacts every facet of life. With the average surface temperature increasing  $0.09^{\circ}\text{C}$  per decade since the 1900s, intense droughts, storms, and heat waves have become frequent occurrences across the globe, debilitating the stability of food supply and access to various communities and habitats (World Wildlife Fund, n.d.). Melting glaciers, rising sea levels, and warming oceans destroy habitats, alter the food chain, and influence the migration patterns of people and animals (World Wildlife Fund, n.d.). The main driver

of such change has been human production of greenhouse gas (GHG) emissions (United Nations, n.d.). Further, particulate emissions can cause dangerous short and long term impacts to human health, and in Copenhagen alone are responsible for over 500 premature deaths per year (Wiegman et al., 2014).

In Copenhagen, Denmark, approximately 27 million tons of GHGs were released into the atmosphere in 2020 (Ritchie & Roser, 2020). About 44% of these emissions came from the transportation sector (Tiseo, 2019). To alleviate these issues, Denmark's national Climate Act aims to reduce greenhouse gas emissions by 70% by 2030, and to mandate the decarbonization of all sectors by 2050, as part of their 2050 carbon neutrality goals (Mulhern, 2021). Though the country has made considerable efforts to mediate the ramifications of climate change, little action has been taken to specifically target freight and delivery-related emissions (Raynor, 2021). Miljøpunkt Amager, a non-profit organization that promotes and carries out sustainability

initiatives on the island of Amager, seeks to provide the local community with sustainable, zero-emission alternatives to last-mile freight delivery.

Our goal was to work in collaboration with Miljøpunkt Amager and assess the feasibility of incorporating emissionless freight transportation into the delivery models of local businesses within the 2300 postal code of Copenhagen. Specifically, we examined the transition away from traditional fossil-fuel based delivery methods to the use of cargo bikes in the last-mile delivery scheme. Further, we aimed to create a set of recommendations for local businesses that would equip them with the necessary information required to incorporate sustainable and emission-free delivery methods into their current delivery models. Over the duration of this project, our team met with municipality workers, delivery service providers, and local businesses in Amager. We gathered and assessed information on governmental incentives, delivery logistics, and barriers to sustainable transportation transitions to produce our recommendations.

# Chapter 2

## Background

In the past decade, Denmark has become a world leader in implementing rigorous climate action. This has been seen with the proliferation of renewable energy sources, food waste solutions, and green mobility. In Copenhagen, the nation's capital city, the local municipality has produced their own aggressive climate plan, and hopes to make the city carbon neutral by 2025, twenty-five years earlier than the country's national goal. Miljøpunkt Amager, is a non-profit communal organization that aims to promote sustainable considerations by furthering the development of local environmental projects and ideas. Miljøpunkt Amager organizes collaborations with other sustainable organizations and holds many of their own 'green' programs that work to combat the climate crisis. In collaboration with Miljøpunkt Amager, our team investigated the feasibility of an emission-free urban freight transportation network between various businesses in Amager, Copenhagen. In this chapter, we will examine emission rates of current delivery

systems, strategies to monitor and limit such emissions (city planning and alternative delivery systems), and the current sustainability policies implemented in Copenhagen.

### 2.1 Emission Rates of Current Freight Transport Systems

According to the Union of Concerned Scientists, burning fossil fuels in internal combustion engines emit many harmful pollutants, including ultrafine particulates (UFPs), volatile organic compounds, nitrogen oxides, carbon monoxide, sulfur dioxide, and greenhouse gases (Union of Concerned Scientists, 2018). These chemicals can have devastating short-term and long-term effects on communities, including smog, health concerns, and long-term irreversible climate change (Union of Concerned Scientists, 2018). Freight traffic has an outsized environmental impact compared to other vehicles caused primarily by emission

of these harmful chemicals. In Denmark, 45% of road transportation carbon emissions are produced by light or heavy duty vehicles, the category under which freight delivery vehicles are classified (Winther, 2020). In addition, the average light/heavy duty vehicle emits around seven times more particulate pollution than the average passenger car (Winther, 2020). Furthermore, these light/heavy transportation vehicles alone are responsible for a majority of mobility-related particulate emissions, despite being outnumbered by passenger cars 6:1 (Winther, 2020). A 2014 study of particulate pollution in Copenhagen paints a similarly bleak picture for UFPs, noting that while traffic levels were minimally correlated with UFP levels, the levels more than doubled in construction sites that had a large number of diesel engines present as can be seen in Figure 2. The delivery services that employ these diesel vehicles often have fleets of dozens of these vehicles servicing an area.

Greenhouse gas emissions present many large-scale problems long term, says the Union of Concerned Scientists: “[g]lobal warming is leading to more frequent and intense heat waves—especially risky to children and elderly people—and to sea level rise, flooding, and drought that can devastate local communities” (Union of Concerned Scientists, 2018). As diesel engines are a significant source of greenhouse gas emission, the Union of Concerned Scientists notes that “[a]ddressing heavy-duty vehicle pollution is critical for improving air quality and reducing global warming emissions in communities” (Union of Concerned Scientists, 2018). In addition to the long-term effects of global warming, there are short-term effects to consider, such

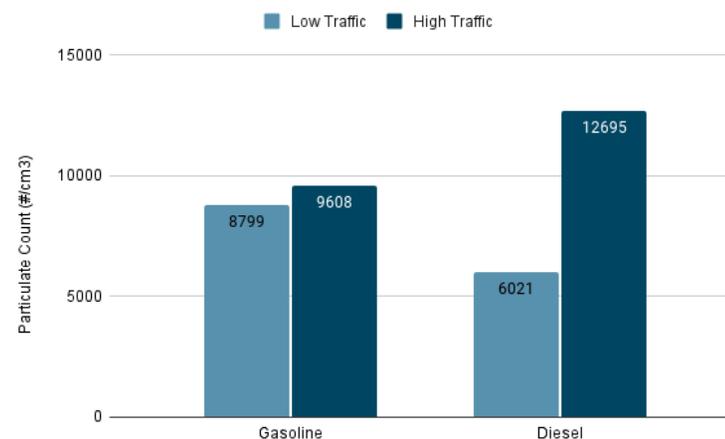


Figure 2: Disparate impact of diesel and gasoline vehicles on particulate emissions (Wiegman et al., 2014).

as how UFPs alone cause over 500 premature deaths per year in Copenhagen (Wiegman et al., 2014).

## 2.2 Regulatory Strategies to Limit Vehicle Emissions

A common approach to minimizing travel-based emissions has been to modify the infrastructure and design of cities themselves. In Barcelona, Spain, there are ongoing efforts to implement the Superblock model (Mueller et al., 2020). The Superblock model is designed around gridded blocks that limit vehicle usage on internal roads. 503 such superblocks are proposed to be created in Barcelona. Further, researchers studying the Superblock design estimate that the design could prevent

667 premature deaths (Mueller et al., 2020). Today, a portion of these superblocks have been implemented across the city with more on the way. What previously were arterial roadways would be replaced with smaller green corridors. Only residential traffic would be allowed. More green space was created within the current existing blocks and residents are encouraged to travel on foot or by bike rather than to drive when it is unnecessary. Buses and public transit are also encouraged when traveling between these blocks. These urban design changes are intended to reduce the emissions within these neighborhoods along with benefits to more efficient internal heating within the blocks and a reduction in noise pollution. Barcelona also employs DUM (Urban Good Distribution) parking spots – designed for use by delivery and freight vehicles at certain times of day – across the city and around the superblocks. DUM parking spaces are designed as dedicated spots to bring freight closer to businesses. In the Superblock model, DUM spaces are located around the periphery of the larger superblock. This doesn't guarantee proximity to the innermost areas of a block, meaning delivery into the center of superblocks takes extra effort and requires alternative methods of transport, such as by hand. There is a trade-off for models similar to Barcelona's superblocks where vehicle presence and emissions are reduced. However there is an increased effort required for urban planners to renovate and alter the superblock roads. Not every city can adopt or undergo the large amounts of modification required to match this method, especially older cities where the layout is already firmly set in stone. Some cities currently have similar, less strict

designs, such as the Danish Traffic Islands that include groups of buildings surrounded by local streets that are connected with major arterial roads.

Areas with emission regulations, often referred to as Low Emission Zones (LEZs), have been designated as an attempt at minimizing traffic pollutants. The cities of Berlin, Munich, London, São Paulo, Singapore, and Copenhagen have all started such projects. A study in 2022 found the actual regulations of these LEZs vary in implementation and outcome (Tarrío-Ortiz et al., 2022). Some LEZs have limits to the specific time of day certain vehicles can be on the road, or levy fees for congesting traffic during peak hours. After the implementation of Madrid's LEZ in the center of the city, private vehicle usage dropped from 50% to 20% as residents opted for more public transportation, ride sharing, or pedestrian travel (Tarrío-Ortiz et al., 2022). London plans to implement automated cameras that would scan cars and their license plates to identify non-compliant vehicles and plans to eventually ban diesel vehicles altogether in an in-progress "Ultra" LEZ with tighter restrictions. For the time being, diesel vehicles that are not outright banned are required to be adjusted or modified with certain filters, if possible, in order to enter the zone (Mudway et al., 2019).

However, Low Emission Zones have varying outcomes. The London LEZ has been found to have positive effects. Studies found over a five-year period the number of children in the study living in areas with excess nitrogen dioxide (NO<sub>2</sub>) levels, an emission related pollutant, fell from 99% to 60%. The children also had a reduction in lung illness related to the air

pollutants (Mudway et al., 2019). In Berlin’s LEZ, there wasn’t a considerably noticeable effect on NO<sub>2</sub> seen with only a net change less than a percent, yet in Munich there was a noticeable decrease with a net change of -10% (Gu et al., 2022). It should be noted that LEZs affect all traffic and not just freight or delivery vehicles specifically. Instead, freight-related vehicles are affected indirectly due to regulation of diesel vehicles. Systemic changes need to be made specifically within freight deliveries to reduce the presence of pollutants.

## 2.3 Strategies to Reduce Emissions from Modern Delivery Methods

The “last mile” refers to the portion of the delivery scheme whereby goods are transported to a final destination; whether this be between a package distribution center and storefront or storefront to customer. The last mile is one of the most critical points within the supply chain, as modern delivery companies are attempting to make this leg of the journey more sustainable. Recently, such delivery companies are transitioning to using electric vehicles (EVs) in their last mile delivery logistics. Though practical in delivering goods for last mile logistics, such vehicles both increase urban congestion by perpetuating car-dominated infrastructure, and require the unsustainable mining of metals such as lithium or cobalt (Nkulu et al., 2018). Moreover, unless the energy used to power EVs are produced directly from renewable sources, there would be “no appreciable

contribution to environmental protection” (International Trade Administration, 2021). In a case study based in Italy, it was found that EV freight vehicles actually cause an “increase of about 50% above the CO<sub>2</sub> already emitted from the normal production of electricity” (International Trade Administration, 2021). Therefore, in this section we explore another alternative to traditional freight delivery: cargo bikes.

The capabilities of cargo bikes are very well suited for last mile delivery “due to the characteristics of cargo and means of transport” (Nürnberg, 2019)]. In the European Union, cargo bikes are currently in use, both in “the form of specialized courier companies,” and up to “large logistics operators, who introduce cargo bikes into their supply chains in urban areas” (Nürnberg, 2019). Currently, there are a variety of cargo bikes available on the market, and each type can address different delivery load needs. These can range from post bikes, which can carry maximum loads of 50 to 75 kilograms, and all the way up to trikes, which can carry maximum loads between 150 to 500 kilograms (Nürnberg, 2019). Post bikes are typically two-wheelers with the same frame as that of a conventional passenger bicycle. Usually, post bikes have a cargo space in front of the handlebars and/or behind the seat (Nürnberg, 2019). In Copenhagen, post bike deliveries are typical for food delivery services, with one popular example being Wolt. The popularity of using Wolt bikers is due to the size, shape, and placement of the basket in the bike’s cargo area. In contrast, trikes are multi-wheeler bikes with the largest cargo space available (Nürnberg, 2019). Chainge, a sustainable delivery company that delivers

goods to companies via electrically assisted cargo bikes, uses trikes as pictured in Figure 3.



Figure 3: Trike-style cargo bikes as used by delivery service Chainge.

According to an analysis done on cargo bikes in urban logistics, one of the possible benefits of using bikes for freight delivery is that they may decrease road congestion in urban settings (Nürnberg, 2019). Currently in Copenhagen, passenger bikes have their own dedicated lanes and can pass by, overtake, and maneuver around each other more effectively than street vehicles. Therefore, there is a possibility that using cargo bikes may reduce congestion of city roads, as cargo bikes would use the bicycle paths, allowing them to avoid traffic jams (Nürnberg, 2019). Along with greenhouse gas reduction, bikes do not

produce any appreciable amount of noise pollution or intense vibrations. One of the most beneficial effects of switching to cargo bike delivery is their lack of exhaust emissions, which can have a “direct impact on improving air quality in the city” of Copenhagen (Nürnberg, 2019). The greatest constraints of such bikes are that they are more limited in size, weight, and capacity of cargo when compared to a traditional freight delivery vehicle and cannot maintain the same pace over great distances at full capacity. However, the variety of different bikes available can address different delivery load needs of different companies, especially small businesses.

## 2.4 The Current State of Cycling and Societal Infrastructure of Amager, Copenhagen

In a study completed in Copenhagen in 2017, it was found that 44% of the emissions released came from the transportation sector (Tiseo, 2019). Interestingly, as of 2020, 78% of Denmark’s energy came from renewable sources (Ritchie & Roser, 2020). However, despite this feat, the country still released 26.19 million tons of GHGs in the same year (Ritchie & Roser, 2020). Though the data from Ritchie & Roser only provides information up to 2018, GHG emissions coming from the transportation sector have been steadily on the upwards track since 1990; they have steadily increased for the past two decades with no sign of decreasing. This trend does not hold

true for other sectors. Emissions from electricity and heating production have experienced a dramatic reduction throughout the same timeline.

In an effort to reduce GHG emissions, Copenhagen Municipality has been promoting green mobility initiatives and cultivating “cycling culture” throughout the city. For example, approximately 80% of citizens ride bikes frequently, with cycling accounting for 26% of all trips under 5 km and 16% of all total trips in the country (Raynor, 2021). Further, about 26% of all families with two or more children own a cargo bike, expanding the bike from single-use to family-use, and reducing the need for cars as a means of family transportation (Cycling Embassy of Denmark, 2021). Laws in Denmark emphasize the expansion of alternative forms of transportation in the hopes for an overall reduction of GHG emissions from all sectors (Henderson & Gulsrund, 2019). The more progressive politicians in Copenhagen locally support legislation that makes driving itself less convenient rather than exclusively pushing pro-cycling policy (Henderson & Gulsrund, 2019). While the politically conservative parties see car ownership as a personal choice, the support for car ownership is much lower compared to car-dependent countries such as the U.S. and Germany (Henderson & Gulsrund, 2019).

Bicycle infrastructure takes many forms in Denmark and serves as one of the main draws for citizens of the country. On roadways with a speed limit below 30 kilometers per hour, bikers and drivers share a lane like they do in many U.S. cities. However, unlike the U.S., road infrastructure in Copenhagen includes

textured streets, tight turns, and narrow lane widths to both promote and force drivers to maintain low speed limits (Pucher & Buehler, 2008). Busier streets often include a dedicated bike lane separated from the rest of the traffic by either a painted line or parking lane for cars (Pucher & Buehler, 2008). To maintain safety some streets even go as far as to have a third level of curbing to separate cars from cyclists, and cyclists from pedestrians; these systems are used to minimize accidents between different modes of transportation. Another strategy that city planners have used to promote cycling has been to create paths through parks exclusively for pedestrians and bikers (Pucher & Buehler, 2008). Copenhagen also maintains distinctly separate traffic signals for cyclists. These signals are specifically designed to prevent blind-spot collisions between cyclists and drivers, better enabling these two modes of transportation to coexist on the road (Pucher & Buehler, 2008).

While these solutions strive to promote alternative forms of transportation, they do not specifically tackle the issue of freight or cargo-related emissions. Copenhagen aims to reduce transportation-related emissions by means of policy changes. As mentioned in Section 2.2, Copenhagen has a designated Low Emission Zone or LEZ. In Copenhagen specifically, the most recent LEZ regulations went into place in July of 2021 (*Lorries and Buses*, 2022). Diesel-powered vehicles weighing over 3.5 tons must have a specific particle filter to enter the LEZ. However, by law these filters only have to remove 80% of particulate emissions for heavy diesel vehicles (Ministry of the Environment & Food, 2020). The requirement for 80% removal does not exist for

lighter classes of vehicles. Lighter vehicles must have particulate filters but are not required to meet a specific removal efficiency rate (Press-Kristensen, 2014). We are told by residents these filters also degrade over time and are often left unreplaced. However, there are many exceptions to the rule. Emergency vehicles, vehicles that are registered for veteran driving, vehicles registered abroad, or vehicles more than 30 years old are exempt from meeting the regulation of the LEZ in Copenhagen (*Lorries and Buses*, 2022). There is also a specific route from Nordhavn, a high-volume international port, where vehicles are exempt from the LEZ regulations. These regulations actively limit emissions and encourage freight trucks with additional emission filtration; it does not limit the amount of transport being done by freight vehicles.

One of the areas partially covered by the LEZ region is Amager shown in Figure 4. Amager, the most densely populated island in Denmark, is partially within the borders of Copenhagen and (*Neighborhood Guide: Amager*, n.d.). The 2300 area code – the portion of Amager contained within Copenhagen – will be the focus of our project and this paper. One option we considered is cargo bikes and their feasibility. Being human-powered, cargo bikes do not release harmful greenhouse gases and therefore could significantly cut back on the amount of air pollution being emitted. This project will explore the possibilities and ideas of emission-less freight delivery within the Amager area.

In 2012, the Copenhagen Municipality released its first version of the *CPH 2025 Climate Plan*. In this document, they

underscored that the “demand for green modes of transport must be increased” from the prior status quo (Copenhagen Municipality, 2012). According to the *Copenhagen Climate Projects* report, the Copenhagen Municipality has budgeted an expenditure of DKK 566 million on green mobility, for the main purpose of “improv[ing] conditions for cyclists” (Copenhagen Municipality, 2016). Investments towards expansion of a “city of cyclists” is the second largest municipal investment, with 23% of forecasted investments to be allocated to that initiative (Bohr et al., 2021).

Since the first version of the 2025 Climate Plan, Copenhagen’s municipality has worked to develop the city as a cycling city. According to the *CPH 2025 Climate Plan - Roadmap 2021 - 2025*, the city has implemented projects geared towards electric and other gasoline-alternative transportation. For example, the local government has implemented intelligent traffic control and traffic information systems in the area, improved bus rapid transit, experimented with electric buses, and supported the use of hydrogen-powered cars by implementing free parking for these cars.

## Current Cycling Projects

In terms of cycling-based mobility projects, the local government has expanded the cycling infrastructure within the city, including the “cycle-track network, Cycle Superhighways, Green Cycling Routes, and bicycle parking,” (Copenhagen Municipality, 2020). The city recognizes that incentivizing individuals is

key to promote cycle culture.

**Cycle Superhighways** In terms of the Cycle Superhighways, the Copenhagen Municipality has established a total of eight cycle superhighways (Copenhagen Municipality, 2020). According to the data, the cycle superhighways allow for a “23% rise in cyclists on the routes, of which 14% are transitioning from car travel” (Copenhagen Municipality, 2020).

**Bike-Sharing** Moreover, to achieve their carbon neutrality goals by 2025, Copenhagen’s new city and commuter bike system is “intended specifically for commuters, with more than 1,800 electric bikes accessible at major metro and train stations” (Copenhagen Municipality, 2016). However, it is important to note that there have been some limitations to growth in this area, “particularly due to the municipal capital expenditure ceiling” (Copenhagen Municipality, 2020).



Figure 4: Map of Amager, Denmark (Google, n.d.).

# Chapter 3

## Methodology

The aim of this project was to recommend a plan for business owners in Amager to replace their last-mile diesel-based delivery with sustainable delivery systems. Recommendations will be created by understanding the specific needs of local business owners and connecting them to sustainable delivery solutions. To do this, our team conducted interviews with the three key stakeholders: municipality workers, business owners, and delivery services. From these meetings, we sought to understand the current government initiatives for sustainable mobility, the logistics and mechanisms of freight transportation, and the perceived barriers to adopting sustainable delivery methods. By sourcing the information that was gained from these interviews, we then mapped out the transition process between diesel-based delivery services to bicycle-based, creating an interconnected network between the three stakeholders. Our four main research questions were:

1. What government incentives for small businesses currently

exist to assist in transition to sustainable solutions?

2. What are the current delivery structures in use by small businesses in Amager?
3. What barriers do businesses experience when considering sustainable transitions?
4. What solutions could be pursued to encourage the use of cargo bike delivery?

### 3.1 Investigated Government Initiatives for Sustainable Mobility

Our first objective was to investigate government initiatives that promote sustainable mobility, because understanding the political support systems and obstacles that the city faces would

influence the nature of our research. To satisfy this objective, we sought to know the following:

- What new projects are there in regards to sustainable mobility?
- What is the level of involvement that the government takes when working on sustainability initiatives?
- How is the government preparing for the transition to sustainable methods of mobility?

The answers to these questions will guide our research for this section, and ultimately function as a reference to look back on in our discussion and interpretation of results.

## Literature Reviews

We began our research with understanding the current climate action projects that the Copenhagen Municipality is undertaking. Key materials that were examined included *The CPH 2025 Climate Plan* and *The Action Plan for Green Mobility (Short Version)*. The data and information gained from review of these two articles enabled us to answer our first and third questions. However, in doing this study, we kept in mind the ideas introduced in both *The CPH 2025 Climate Plan* and *The Action Plan for Green Mobility (Short Version)* were only the officially adopted government plans and roadmaps. We sought to find the current status of Copenhagen's progress in their climate action plans. This data would ultimately come from our interviews with municipality workers.

## Municipality Interviews

To get a more solid understanding of where Copenhagen currently stands with these goals, we interviewed Helene Albinus Søgaaard, Project Manager in the Technical and Environmental Administration focusing on Copenhagen's sustainable mobility plan (see Appendix A). Søgaaard's projects place emphasis on pedestrian foot traffic and improvement of the city's air quality. Areas of discussion included the following:

- The projects that Søgaaard is currently working on, as well as past projects that were recently completed (i.e., parking strategies, city planning, speed limit reduction)
- Funding for sustainable mobility projects and municipality influence of the program's processes
- How recent climate projects address and implement the transition from traditional to sustainable methods

The discussions with Søgaaard generally answered all of our objective's research questions (mentioned above). At the end of the interview, Søgaaard recommended we contact her colleague that is heading the Green Mile Project, which aims to promote the transition from using diesel transportation to renewable energy options. We were unable to reach this colleague for comments.

## 3.2 Investigated the Current Delivery Structure Used by Businesses in Amager

The purpose of this objective is to understand the state of delivery for businesses in Amager, our area of concern. We want to gather a baseline for the current methods to determine what is already sustainable, and what is not. Primarily we want to know:

- What services exist to transport goods?
- What methods are businesses using (if any) to have products delivered to their stores? Are these methods sustainable?
- What methods are businesses using (if any) to have products delivered to their customers? Are these methods sustainable?

### Delivery Services

We conducted both formal and informal interviews with delivery services to discuss how they handle moving freight and the sustainability of their processes (see Appendix A). There were two prominent companies we interviewed, Økoskabet and Chainge. We chose not to interview large traditional delivery services, such as DHL and PostNord, both due to the difficulty in establishing contact, and they were less likely to divulge

information. They are also much less flexible of a service because of their size. Økoskabet is a company that provides drop off locations for produce in the form of sustainable closets with limited access. They offer a method of delivering produce from one central location out to these locations via an electric van, but are open to producers' making their own sustainable deliveries to or from these locations in the future. Chainge is a delivery service that offers limited warehouse capacity and bike-based delivery to store fronts. They work directly with producers to distribute products from their delivery locations across Copenhagen.

### Local Businesses

We also worked in small teams to visit stores in the Amager central area. We met a variety of different businesses. Some categories include cafes, plant stores, craft stores, an eCommerce shop, clothing and shoe, and baby goods. We were introduced to some via Miljøpunkt Amager to schedule interviews. Others we met by going door-to-door or by referral from other businesses, without a scheduled interview (see Appendix A). We had no difficulties visiting stores and speaking to business owners that we had prior correspondence with, but in some cases, they were not receptive to us when we introduced ourselves in person without a formal introduction beforehand. This is most likely due to our age or not being native Danes. Another issue was that businesses may be too busy to stop and speak to us during work hours. The majority of these interviews were conducted

in person on premises, where we discussed how a store received their various types of products. If a business offered delivery to end customers, we also discussed how this was conducted. We recorded a number of these interviews, all in writing with some in audio format for further review. An important question in all meetings with local businesses was what actions were they taking to make deliveries sustainable? Further, what could they do in the future to implement a more sustainable delivery method? We used the models of the two delivery services as an example baseline for sustainable initiatives in our discussions.

### **Objective-Specific Challenges and Limitations**

A major challenge we experienced when interviewing businesses was avoiding requests for proprietary information. Not all stores were willing to discuss their business model, delivery systems, or other relevant information. We attempted to format our questions in such a way as to minimize requests for proprietary information to promote receptiveness to our questions, but were not always successful. In other cases, businesses were unable to answer questions due to timing and staffing constraints, where no one with pertinent information was in the store or no employees had available time to meet with us.

## **3.3 Investigated the Perceived Barriers to Adoption of Sustainable Delivery Methods**

The purpose of this objective was to gain insight into the most challenging factors when considering a change to sustainable delivery. By doing this, our team can learn the challenges small business owners face when trying to be more sustainable and considering sustainable delivery options. If we can understand these key challenges each business faces, we can identify common themes among them and then we may be able to find solutions that lessen the burden of these factors. Primarily we wanted to know:

- What are businesses' main values and constraints when considering a delivery system?
- What factors limit the ability of a small business to transition to a sustainable delivery model?

### **Transcription**

In order to determine some of the obstacles faced by small business owners, delivery services, and municipalities we conducted a set of formal and informal interviews as mentioned in objectives 1 and 2. These interviews were then transcribed into a text format. The formal interviews were transcribed exactly how they were spoken. The informal interviews were transcribed as notes written down at the times of the interview.

## **Categorization of Interviews**

The resulting transcripts were then broken down into three distinct stakeholder groups. These stakeholders being business owners, municipality workers, or delivery services. Interview transcripts with business owners were used to gain direct insight into the specific delivery-based challenges faced by business owners from their perspective. The business owner transcripts were then color-coded to highlight the important ideas. The ideas were highlighted based on relevance to our four research questions (see Appendix B). Similar ideas were coded in the same color. For example, everything that seemed related to a cost barrier was coded in red. This was done for every interview conducted with small business owners.

## **Coding of Individual Interviews**

Transcripts for the interviews of people working in the local municipalities and delivery services were also coded but looked at with more scrutiny as there were fewer sources and therefore fewer interviews. Municipality interviews were focused on what aid and incentives the municipal government provides to delivery services and small businesses in order to become more sustainable. The transcripts with the municipality were coded with a focus on current and future sustainability initiatives. Interviews with the delivery services were coded for what they can offer to small businesses in terms of sustainability.

## **Analysis of Coding**

The focus of the coding of each type of interview was catered towards the challenges of small businesses and what the municipality and delivery services can offer. This data enabled our team to reasonably summarize the key repetitive factors and challenges among small businesses when looking to transition to sustainable freight delivery. This data also represented the municipality incentives. Comparing this data, our team identified main sources of struggle within our stakeholder network and offered ideas and solutions to assuage some of their challenges when considering a transition to a sustainable delivery system. Through the understanding of perceived barriers of small businesses, we recommended a solution that specifically targets those factors and assist the shift of these small businesses to sustainable freight delivery.

## **Objective-Specific Challenges and Limitations**

Our team acknowledges that one of the challenges of interviews is a small data pool. Our interviews with the municipality and the delivery services have limited pools of interviewees as there are very few people to interview in these fields. Further, they are often hard to contact. Our interviews overall also faced difficulty communicating due to the language barrier. Despite these challenges our pool of interviewees provided valuable and relevant answers to our questions.

### 3.4 Provide Solutions to the Perceived Barriers to Adoption of Sustainable Delivery Methods

- What sustainable actions are some businesses taking that can be recommended to others or implemented globally?
- What are recurring issues across the businesses that can be solved individually?
- What are recurring issues that can be solved through collaboration?
- What are the benefits and sustainable methods that are succeeding for these businesses?
- What recommendations and tenets can be proposed for a business to follow in order to become sustainable in the same ways as other businesses?

#### Identification of Solutions

Having identified the challenges faced by small businesses and delivery services, we then looked at common statements made about challenges by businesses during our interviews. At this stage, we sought to identify common trends across multiple interviews, and identify which factors about a business (size, sector, etc.) correspond to specific challenges. Using this information, we were able to identify available services that

could be recommended to reduce or eliminate the negative impact of these challenges. Based on previously conducted interviews with other key players, and additional interviews, we matched challenges experienced by one category of our key players with the services of other key players.

#### Distribution of Results

One potential challenge of this method of information aggregation is that it works best with a large sample size of semi-structured interviews. Unfortunately, due to time and resource constraints we were only able to collect a modest collection of interview data, which prohibits us from being able to identify specific subcategories to which a solution might apply. However, we were able to collect sufficient data to make useful general recommendations for businesses of comparable size and structure to those we interviewed. We interviewed mostly low-volume single-location businesses, as we believed that those businesses are the most likely to be able to successfully implement sustainable delivery practices, as well as the most likely to benefit from clear information on how to go about implementing such delivery practices.

#### Challenges

Our team acknowledges that one of the challenges of interviews is that they require more time to complete and additional research to find relevant interviewees that are willing to speak to us. Our interviews with the municipality and the delivery

services have limited pools of interviewees as there are very few people to interview in these fields and they were less likely to talk to us. Further, they are often hard to contact. Our interviews overall also faced difficulty communicating due to the language barrier. Despite these challenges our pool of interviewees provided valuable and relevant answers to our questions.

# Chapter 4

## Findings

In this chapter we present our findings on the current delivery logistics practiced by local businesses in Amager, while pin-pointing areas where emission-free transportation can be incorporated. First, we explore how the local government is promoting cycling in an effort to draw conclusions on the likelihood of cargo bikes being used for last-mile delivery. Next, we examine how freight is currently being delivered to and from the small businesses in Amager. After compiling, transcribing, and analyzing our interview recordings (see Appendix B), we are able to present the most notable and repetitive barriers faced by small businesses when considering the transition to bike delivery. Finally, we discuss the limitations of our findings.

### 4.1 Current Municipality Incentivization

By sourcing information from the *CPH 2025 Climate Plan*, *CPH 2025 Climate Plan – Roadmap 2021 - 2025*, and the 2016 *Copenhagen Climate Projects* report, we examine how the local government has promoted and expanded cycling. Included in this section is information regarding the current projects in place to improve “bike culture”, and the challenges that limit the expansion of cycling programs.

Despite the huge effort by the city’s municipality to promote cycling, the “efforts to reduce emissions from passenger traffic from 2010 to 2018 were unsuccessful” (Copenhagen Municipality, 2020). Upon several road analyses done in 2018, while road traffic itself had declined by almost 3%, carbon emissions from passenger car vehicles have risen to 10% (255,000 tonnes) in the same period (Copenhagen Municipality, 2020). In their

2020 report, the local government acknowledged that there still needs to be a sharp reduction in emissions from road traffic to “achieve its goal of carbon neutrality by 2025” (Copenhagen Municipality, 2020).

The stunted reduction of emissions is in part due to the increase in automation of Denmark. According to the local government, it is predicted that the population in the city will “have risen by almost 100,000” inhabitants between 2012 to 2026 (Copenhagen Municipality, 2016). This rapid growth of the city’s population poses a direct challenge to the government-led sustainable mobility efforts, as it is also forecasted that “car ownership will increase” and “the number of cars in Copenhagen may rise by as much as 20%” (Copenhagen Municipality, 2016). Moreover, as the population rises, it is expected that the amount of trips taken by people in passenger cars will also rise, “intensifying the pressure on the city’s infrastructure” (Copenhagen Municipality, 2020). The lowering of motor-vehicle taxes has made it less expensive for cars to be in Copenhagen, which has supported the increase in emissions in the city. According to the CPH Climate Projects report, the overall carbon emissions coming from transportation increased from 24% to 34% in 2015, whereas other sectors have reduced their emissions more dramatically.

Another limitation to the growth of cycling projects can be found with the municipal capital expenditure ceiling, which limits the government’s purchasing of long-term assets. The capital expenditure ceiling was temporarily suspended between 2020 and 2021; consequently, the ramifications of this resulted

in the cycling track network “not being sufficiently expanded to ensure additional switching from cars to bicycles” (Copenhagen Municipality, 2020). Additionally, according to the 2020 roadmap report, “DKK 330 million from the city’s parking income is offset in its block grant” (Copenhagen Municipality, 2020). Block grants are an annual sum of money awarded by the larger governing body in Denmark to the municipalities. There is less oversight from the larger government, so as to allow regional governing bodies (such as the municipalities) to design and implement the programs themselves. In this case, the money absorbed by the Copenhagen Municipality “could have been used to promote green mobility in the city”, but instead was allocated elsewhere (Copenhagen Municipality, 2020).

The final major limitation is that the current infrastructure in Copenhagen does not readily support green mobility, let alone the use of cargo bikes as a means to replace last-mile freight delivery. According to the *CPH 2025 Climate Plan - Roadmap 2021 - 2025*, the necessary functions to support green mobility, such as “charging-station infrastructure, bus lanes, cycling tracks, attractive hubs and bicycle parking, require space in urban settings, which are generally pressured in Copenhagen” (Copenhagen Municipality, 2020). This remains especially true for the inner-city areas, such as Nørrebro, Østerbro and Vesterbro. Improvements that have been made including increased presence of bike lanes, increased bike parking, and bike share programs do not cater to cargo bikes in particular. Bike lanes cannot allow cargo bikes to pass each other, congesting the lanes. Bike parking can not accommodate most cargo bikes and

actually reduce the area they can occupy.

## 4.2 Current Delivery Structure Used by Businesses in Amager

This section will discuss the common delivery practices currently used by small business owners in the 2300 postal code region of Copenhagen. Over the course of six interviews with local business owners and employees, we learned about the delivery logistics used by their businesses. Upon gathering this information, we determined the commonalities and patterns amongst the delivery schemes employed by each business. Through these findings, we have come to understand what delivery methods are in common practice, while also pin-pointing areas in each system that could withstand sustainable, zero-emission cargo bike transportation.

The majority of stores received freight through unsustainable, high-emission delivery services such as Postnord, DHL, or GLS. While some of these major companies occasionally deliver by cargo bike the majority of these deliveries are completed on diesel fleets of vans. Three out of six small businesses reported receiving shipments solely through diesel vans, two such stores received them on a regular schedule of at least once a week. Only one business was almost entirely without diesel deliveries. A common reason given was that delivery methods were controlled by the vendors. One business mentioned they sold over forty distinct brands of which they had no control over how the

products were brought to the store front.

Businesses that opted for more sustainable methods often serviced deliveries to or from their business themselves. One storefront had infrequent van deliveries, some only monthly or twice a year, while the majority of their products were acquired themselves by non-diesel cars at infrequent, unscheduled intervals. A second store had daily bike deliveries to their cafe for fresh baked goods, and would handle acquiring and transporting coffee beans between the supplier, their roasting location, and their cafe themselves. In both cases, their primary products were often locally sourced and self-managed.

## 4.3 Perceived Barriers to Adoption of Sustainable Delivery Methods

If businesses could adopt sustainable delivery methods, emissions from diesel vehicles could be minimized. However, the transition is not simple, especially for small business owners that lack resources maintained by large-scale businesses.

**Business owners typically value delivery systems that do not lend themselves to sustainability.** We found that when businesses were asked to rank their delivery values, punctuality and speed were of paramount importance, whereas sustainable or low emission delivery did not hold as much overall significance. This provides a substantial barrier in the transition to cleaner delivery methods. One study conducted by Aalborg University students, in collaboration with Miljøpunkt Indre By

and Christianshavn, found that “a low CO<sub>2</sub> footprint is considered a medium important quality” from a survey of more than one hundred companies in Copenhagen (Bohr et al., 2021). The study found that punctuality, flexibility, and delivery speeds far outweighed any ecological concern (Bohr et al., 2021). From our own interviews we found that businesses typically cited financial burden when considering delivery methods. Four out of six small businesses we contacted had cited concerns about increased expenditures when considering cargo bike delivery systems. Their concerns consisted of worries they would have to raise prices if goods were delivered to their store via bike, or would have to raise prices of goods delivered to customers by bike instead of the typical services leading to customers being dissuaded from receiving deliveries. Transitions to sustainable options will not be made by a business unless they have social or economic incentives. Based on our interviews, it is evident that bicycle-based delivery is not valued enough to sacrifice the ease, simplicity, and cost of existing delivery systems.

**While Copenhagen maintains their bicycle infrastructure for commuters, it is not suitable to support cargo bike delivery methods.** We observed that in the majority of situations the current infrastructure only supports cyclists with a single passenger bicycle. Bike paths found throughout Copenhagen can only support two traditional bikes to pass each other. The current bike infrastructure does not support the mass transportation of cargo bikes, as the average width of intercity bike lanes vary between 1.85 meters to 2.85 meters, whereas the average width of a cargo bike is 1.5 meters. According

to these measurements, it would be difficult for traditional bikes to share the lane with cargo bikes, let alone having cargo bikes share the lane with each other. Delivery bikes inhibit commonplace passing etiquette and make it difficult to support a large-scale transition to a network of sustainable freight delivery. Additionally, the increased size of bike parking locations in high traffic areas are designed to maximize the number of single-seat, cargo-less bikes. A single cargo bike would not fit into these long rows of bike racks or would block access to several other parking spots in the process. The increased presence of these large-scale bike parking locations reduces the parking opportunities for cargo bikes. The lack of accommodating parking means that while unloading goods, cargo bikes often resort to parking in awkward or inconvenient locations such as car parking spots or in the middle of sidewalks. According to Dr. Andres Felipe Valderrama Pineda, a professor leading the Sustainable Transitions Program at Aalborg University, the current Copenhagen infrastructure is unable to support cargo bike traffic. Pineda States that “infrastructure currently doesn’t support” the ability for cargo bikes to overtake each other or yield to passengers. In a report written in collaboration with Morten Elle of Aalborg, Pineda states that most initiatives are “mainly directed or come from the cities,” whereas road infrastructure is typically handled by the Danish government. This lack of infrastructure makes it difficult for cargo bike-based delivery companies to compete with diesel delivery companies. Chainge, a cargo bike delivery company, cited in an interview that infrastructural challenges were one of the many factors that

make it difficult to compete with large diesel-based shipping companies.

**A barrier to the adoption of sustainable freight delivery noted by one sustainable delivery service is the common misconception of the limitations of bicycle-based delivery.** In multiple interviews conducted, businesses underestimated the capabilities of cargo bikes. Two-thirds of businesses interviewed believed that it was impossible for cargo bikes to meet their delivery needs to any large extent. One business cited the size of their shipments, while another cited the weight. However, based on our discussion with bicycle-based delivery services, three of the four businesses that believed their goods were unsuitable for bicycle-based delivery. Interestingly, our research indicates that a significant amount of the delivery needs of business owners could be met by cargo bikes, either to their storefront or from their store to customers within the city. Of the remaining business, their products could be partially served via cargo bikes.

**The high cost of cargo bike delivery was often cited as a concern among business owners.** Two businesses cited concerns about the expenses that bike-based delivery would pose on either themselves or the customer. One business was not happy with the current expenses when using Postnord but did not have any preconceived notions about the price of bike delivery. Another growing business would like to work with a bike-based company when it becomes financially feasible for them. However, they currently lack the scale and volume of deliveries required to pursue cargo bike deliveries.

As previously mentioned, stores were often at the whims of their vendors for delivery. A strain on these businesses is that individually they have little to no leverage with their vendors when making delivery decisions. The business's profits rely on the shipments from their vendors; however, vendors often sell to many different businesses. According to some businesses certain vendors, especially large brands, are impacted much less if one or a few small businesses cut ties due to their delivery methods. Large brands such as these are also often the brands who have large volume that gets sent out on many vans. To have an impact, a large systemic change would have to happen by many businesses.

While some businesses only serve customers on location, at least two serve deliveries to customers outside of Copenhagen. One cited that they serve the entirety of Denmark. The only services they knew that could handle deliveries to individuals across the entirety of the country were large services such as PostNord, GLS, or DHL. Very few were aware of or could name alternative delivery options that met the same requirements.

# Chapter 5

## Conclusions and Recommendations

In this chapter, we will identify major conclusions drawn from our findings. We will then present our final recommendations for Miljøpunkt Amager, small business owners in Amager, and the Copenhagen Municipality. We will provide a comprehensive understanding of the conclusions we have drawn from our data and explain our proposed solutions drawn from our conclusions.

### 5.1 Conclusions

Our results have provided us with information regarding delivery logistics and bike transportation.

**First** We found that there has been an expansion of government programs to promote bike culture in Copenhagen. However, such expansion of cycling infrastructure is only catered to improve the cycling experience for single-use passenger bikes. While these projects do aim to reduce

the number of passenger vehicles on the road, it does not target the use of light and heavy diesel transport vehicles that emit large quantities of greenhouse gas and particulate matter emissions. Further, these projects are often slowed or halted by lack of funding or mis-allocation of grants.

**Second** We found current infrastructure doesn't support wide-scale incorporation of cargo bikes. One of the reasons why services such as Chainge are not as widely utilized as a delivery service like Wolt is because current infrastructure does not support large-load cargo bikes well. We observed that Copenhagen's cycling infrastructure only supports single-passenger or small basket bicycles. Traditional intracity bike paths are not wide enough to support the expansion and growth of cargo-bike-based delivery services. For example, large load cargo bikes impede and congest lanes and prevent one cargo bike from passing the other.

This takes up valuable pedestrian space.

**Third** For those businesses in Amager that received their freight from unsustainable, high-emission delivery services, it was typically found that deliveries were controlled by the vendors themselves, and not the business. They often cited that they had lack of control over how they received this freight. However, for those businesses that opted for sustainable delivery methods, much of their products were locally sourced and self-managed.

**Fourth** We found that misconceptions about the capacities of cargo bikes were pervasive among small business owners. The maximum loads of cargo bikes were often underestimated by business owners, especially when mainstream bike services can only carry out deliveries that are typically 6-8 kilograms (Wolt, 2021). Some cargo bikes can accommodate more weight, up to 150-500kg. Publicizing the accurate weight capacity and size of a cargo bike could help to alleviate these misconceptions.

**Fifth** Since every business has different retail needs and resources available to them, the recommendations provided in this report must be variable and depend on the context of the business. Some businesses receive goods daily while others only receive deliveries monthly. Further, all businesses may require different logistics due to the nature of their products. Every business has its own set of conditions and circumstances it must function under.

**Sixth** Modernization has placed value and importance on immediacy. During our research, we found that businesses prioritize punctuality and speed over sustainability. This mindset requires sociological restructuring and re-evaluation of values. Businesses should be pressured to focus on public health and sustainability over speed.

## 5.2 Recommendations

### Miljøpunkt Amager Should Publish/Promote Tiered Proposal Flier

Our team recommends that Mijliøpunkt Amager educate local business owners and Amager residents about the variety of cargo bike options that are currently available to the public for delivery purposes. This information can be conveyed via mailing lists, presentations, or infographics and fliers (see Appendix C). This method can combat misconceptions about the load capabilities of cargo bike delivery. In summary, the recommended tiered proposal incorporates room for flexibility, so that each business can modify and incorporate individualized solutions into their own business model. We recommend that Miljøpunkt Amager publicize this information in order to educate local business owners and residents in Amager about the capabilities of cargo bikes and promote sustainable delivery solutions.

## **Educate Small Business Owners on Cargo Bike Delivery Methods**

Our team recommends the following tiered approach to transition unsustainable delivery practices to a more sustainable method via cargo bike transportation. A multi-level approach allows small business owners to take reasonable steps towards sustainable delivery systems based on their personal values, resources, and business models. This tiered approach is detailed in Figure 5. This approach layers solutions in a way that allows a business owner to consider their own delivery needs and find a tier that is a reasonable step to reduce their delivery emissions. Further, by taking this step, business owners might be able to truthfully market their products as delivered sustainably.

## **The Copenhagen Municipality Should Provide and Expand Incentives to Eco-Friendly Transportation Users**

To achieve their 2025 carbon neutrality goals, the local government of Copenhagen should promote zero-emission freight delivery methods to and from businesses. In particular, we recommend an expansion of incentives to businesses that use completely sustainable methods for their deliveries. This remains especially important for small and local businesses that require extra help to transition between delivery models. Further, we believe that investments made by the municipality to promote bike-based deliveries would result in a smoother transition from

gasoline and diesel-based delivery methods to alternative, sustainable delivery methods. In Amager specifically, this could lead to decreased vehicle congestion, resulting in lower emission outputs from freight delivery trucks and vans. Additionally, we strongly recommend improving bicycling infrastructure for the use of cargo bike transportation, as this could result in the expansion of bicycle delivery service capabilities. Improvement in bike infrastructure could make cargo bike usage more accessible to the general business owner. This would also allow Copenhagen to make strides towards their climate goals to be carbon neutral by 2025.

## **Recommendations for Further Research**

Our team recommends additional research into the aggregation of the logistics of cargo bike delivery. We would like to cite a study conducted by Aalborg University CPH and Miljøpunkt Indre By & Christianshavn to gain further traction towards this effort (Bohr et al., 2021). The report *Cargo Bikes for Freight in Inner City Copenhagen* investigated the feasibility of freight delivery as the last-mile link of a delivery chain. While the report focused on the inner city of Copenhagen, it investigated cargo bike freight delivery from a much broader scale. We believe that the proposed solution in the report needs to be further investigated and pursued.

The report conducted by Aalborg University CPH and Miljøpunkt Indre By & Christianshavn investigated several logistical possibilities to the implementation of cargo bike delivery. Their

## TIERED APPROACH

- **1. HIRE A CARGO BIKE SERVICE**  
Investigate the feasibility of hiring a cargo-bike service to warehouse and deliver a company's product.
- **2. INVEST IN A CARGO BIKE**  
Investing in a designated cargo bike for the small business that allows employees to make deliveries themselves.
- **3. USE PERSONAL BIKES**  
If the usage of a personal bike to make small deliveries is possible, it is highly encouraged!
- **4. LIMIT VEHICLE USAGE**  
Limit vehicle usage for deliveries in any way possible. This could involve using a personal car instead of a large diesel-based delivery service or sharing a car with neighboring businesses.

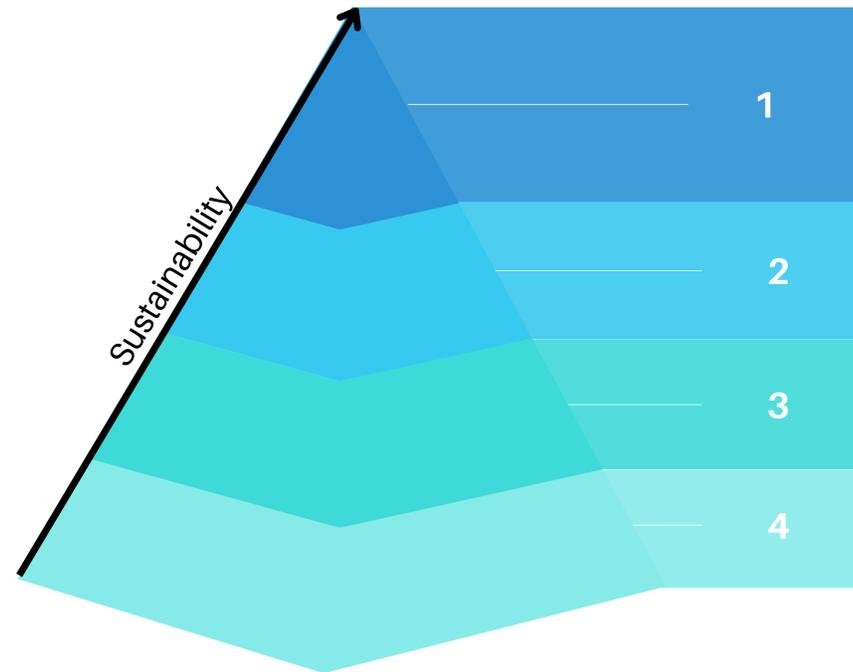


Figure 5: Tiered approach for small businesses implementing sustainable delivery.

findings and conclusions closely matched our own but at a larger scale over a longer timeframe. Similar case studies with the same approach and time span can and should be conducted in Amager as well to assert that their findings were entirely applicable. The report goes on to recommend an approach they call the “SocioCycle” (Bohr et al., 2021). This approach would effectively aggregate small business deliveries and therefore drastically increase the feasibility of cargo bike delivery. SocioCycle is a solution that takes up the task of delivering “unwanted distribution categories” such as some direct deliveries (typically those made by small businesses) or fresh food subscription services. The authors also recommended the implementation of a cargo bike renting service in which small businesses could rent or subscribe to a subscription for use. Further, they go on to describe a “SocioCycle Center” which would be an established professional distribution center (Bohr et al., 2021). The report states that having several of these distributions centers around the perimeter of inner-city Copenhagen could effectively consolidate and integrate shipment from small business owners. This would limit the amount of overall delivery trips necessary and therefore make bicycle shipments more effective.

As we do not feel the SocioCycle Center is feasible without great motivation or extensive change we do acknowledge that this idea could be very effective. We also believe that a strategy similar to SocioCycle Center could be implemented in Copenhagen Amager due to the similarity to inner city Copenhagen. We recommend that research be continued in this area and perhaps be pursued by Miljøpunkt Amager.

# Chapter 6

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# Appendix A

## General Interview Questions

### A.1 Business and Shop Protocol

#### Introduction

Hello, we represent a team working alongside Miljøpunkt Amager to research alternative freight options. We are researching how freight and cargo are delivered to different businesses in Amager and would like to discuss a select few questions with you on how your business handles deliveries. Would you be able to set aside a short period of time to meet with us to discuss these questions?

#### Questions:

- How many days of the week do you receive deliveries?
  - On average, how many different delivery vehicles arrive these days?

- Do you have any say in how you receive your products? Is it up to the vendor or suppliers?
  - If so, to what degree does it affect your decisions?
  - If not, what do you wish you could control?
- What kind of vehicles do you receive your deliveries from?
- If given the chance, would you wish or allow some of your products to be delivered to your business by bicycle, cart, wagon, or another manual vehicle?
  - Do you have any specific products that come to mind?
  - What special requirements or care does delivering your products require?

## A.2 City Protocol

### Introduction

Hello, we represent a team working alongside Miljøpunkt Amager to research alternative freight options. We are researching how freight and cargo are delivered to different businesses in Amager and would like to discuss a select few questions to understand current projects and incentives concerning cargo bike delivery. Would you be able to set aside a short period of time to meet with us to discuss these questions?

### Questions

- What is the local government currently doing to promote sustainability initiatives?
  - What sustainability projects are at the forefront?
- Who is in charge of ensuring the viability of sustainability initiatives
  - Are there any incentives to promote cleaner forms of transport?
- What is the level of involvement that the government takes when working on sustainability initiatives?
  - Is the government looking for partners to promote sustainability/cycling programs?

- Is the government interested in providing financial assistance to promote sustainability/cycling programs?

- How is the government preparing to transition sectors to use sustainable alternatives?
- Roadmap timeline?
- Is there funding to help ease the transition between traditional and sustainable transportation for small businesses?

## A.3 Bicycle-Based Delivery Service Protocol

### Introduction

Hello, we represent a team working alongside Miljøpunkt Amager researching alternative freight options. We are researching how freight and cargo are delivered to different businesses in Amager and would like to discuss a select few questions with you on how your business handles deliveries. Would you be able to set aside a short period of time to meet with us to discuss these questions?

### Questions

- What are the main sources of cargo you deliver?
- Logistics and planning of cargo delivery routes?

- What are the typical locations you deliver to?
  - How far is your reach?
- What are the typical amounts of cargo you deliver (weight, size, number)?
  - Can this be changed based on the type of bike?
- How long is your typical delivery route?
- Do you have staff who ride the bikes?
  - Questions specific to bike deliveries
- What went into the planning of where the bike stations would be located?
  - People you consulted with for plans/considerations?
- What are some of the overall costs associated with this program?
- What up-keep is required for managing the bikes?
  - How often are bikes checked on/repaired?
- How many bikes are typically available at once?
- Do you know how much weight the bikes can handle?

# Appendix B

## Interview Analysis Methodology

### B.1 Common Detail Comparison

We created tables to compare common elements between the various small businesses that were interviewed. We chose to compare the frequency of deliveries in and out, method or services for deliveries, vehicles used in these deliveries, etc.

	Response	Count	X	X	X	X	X	X
Sustainability	Sustainable	1						
	Mix	2						
	Unsustainable	3						
Cites Cost of Bikes	Yes	3						
	No	3						
	Uncertain							
Cites Cost of Delivery	Yes	4						
	No	2						
Claimed to be Undeliverable	Yes	4						
	No	2						
Uses a Bike	Yes	2						
	No	4						
Uses personal vehicle (Not Bike)	Yes	1						
	No	5						
Uses Major Service	Yes	5						
	No							
	Uncertain	1						
Regular Schedule	Yes	2						
	No	2						
	Uncertain	2						
Mentions Locally Sourcing	Yes	2						
	No	4						
Delivers to customers	Yes	2						
	No	4						
Receives from van >1 a month	Yes	3						
	No	1						
	Uncertain	2						

## B.2 Interview Color-Code Methodology

Color was associated based on the objective and associated researched question. If a piece of speech provided relevant information to an objective, the speech was highlighted in the predetermined color of the associated objective. The speech was only highlighted if it provided factual and relevant information. This technique was applied to formal interviews in which speech was transcribed from a recording, and informal interviews where written notes of the interview were provided. The color itself has no meaning other than to differentiate between separate questions. We did have to consider the biases of the interviewee.

The highlighted blurbs of speech were then sorted into their designated color groups and analyzed for meaning in terms of the research question. Similar answers among separate interviews were weighted more heavily.

Objective	Research Question	Associated Color
1	What are the current government initiatives for sustainable mobility?	Yellow
2	What is the current delivery structure used by small businesses in Amager?	Green
3	What are the barriers to the adoption of sustainable delivery?	Red
4	How do we overcome perceived barriers?	Blue

# Appendix C

## Cargo Bike Flier

Delivering or receiving packages?

# TRY CARGO BIKES!



## Cargo Bike Capabilities

Cargo bikes come in a variety of types, sizes, and capabilities. Some are **small and great for personal use!** Other types of larger electrically-assisted cargo bikes can carry up to **150 kilos** and have **1.5 cubic meters of space**.



## More Sustainable Delivery Options

There are a variety of options to make each small business more sustainable. These options can be catered towards each business' needs and become a green marketing tool.

### Limit Vehicle Usage

Use a personal car instead of a large diesel-based delivery service or sharing a car with a neighboring business

### Use Personal Bikes

If possible it is highly encouraged to make small deliveries using a personal bike

### Invest in Cargo Bikes

Consider investing in a designated cargo bike for the small business

### Bike Delivery Services

Investigate the feasibility of utilizing a cargo-bike service to warehouse and deliver products

