Bicycle Logistics in Copenhagen: a planning perspective

Master thesis in Nordic Urban Planning Studies

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Abstract

Goods transport is responsible for a large share of road traffic emissions, especially in urban areas with concentrated logistics activities. Bicycle logistics, defined as professional logistics using cargo bikes, is one solution for making city logistics more sustainable. Bicycle logistics is conceptualised as a niche that has emerged at the crossroads of technological innovations like electric assist, and wider societal pressures such as climate crisis. This thesis looks at bicycle logistics from a planning perspective. Even though several social groups concerned with bicycle logistics see its advantages, it is still difficult to compete with the established diesel-based regime. Key actors were interviewed to determine the needs of the emerging bicycle logistics niche and to map the current planning situation as well as potential future measures. It can be concluded that transition to bicycle logistics in Copenhagen can be planned for by pursuing a more regime-testing policymaking pathway. Public sector's own climate goals and environmental and liveability targets should weigh more and be a guideline for decision-making. A holistic set of measures would be the best, but a challenge is that the measures belong under different jurisdictions: some relevant for planners (guidelines for roadworks and bollard design, proposing infrastructure solutions and planning initiatives), some for municipal politicians (setting goals and targets, making ambitious decisions guided by existing climate goals), and some for state-level authorities (revising legislation about what the municipalities can decide on, revising national legislation for cargo bikes).

Introduction

The purpose of this thesis is to give an insight into the emerging niche of bicycle logistics (BL) in Copenhagen through a planning perspective. For this, qualitative interviews with some of the key actors in the field were conducted to map the needs in this emerging branch of logistics, as well as the barriers and the enabling aspects. The main interest has revolved around how planning relates to sustainable transitions in Copenhagen, a city often praised for its sustainable ambitions.

Transport is responsible for around 30% of EU's total CO_2-emissions, and 72% of this comes from road transport (Europa-Parlamentet 2019). Up to 30–40% of CO_2-emissions in central urban areas stem from vans and trucks (Gudmundsson & Krawack 2021: 5).

Transport emissions can be further divided to retail and general cargo (30–50%), transport of building materials and soil (25–30%), van driving for service purposes (10–15%), and parcel distribution (4–6%) (ibid.). The share of parcel distribution has been relatively low but is rising rapidly due to increase in e-commerce (ibid.: 25). This will put a pressure on logistics systems in cities, especially on last mile logistics (LML).

Both Denmark and the City of Copenhagen have climate goals. Denmark is aiming to reduce CO_2 emissions by 70% by 2030 compared to 1990 levels and should be climate neutral by 2050 to meet the goals of the Paris climate agreement (Retsinformation 2020). The City of Copenhagen has a goal to be climate neutral already by 2025 (KK 2012a), and road traffic is one of the biggest challenges here (Europa-Parlamentet 2019).

One solution to make logistics in the cities more sustainable is to move part of the goods with cargo bikes. Melo & Baptista (2017: 30) define BL as "professional logistics like delivery services, waste collection or small trade services using cargo bicycles (2, 3 or 4 wheelers either electric or conventional) and bicycle trailers". According to Schliwa et al. (2015: 52), "cycle logistics describes the use of human-powered or electrically-assisted standard bicycles, cargo bikes and cargo tricycles for the transport of goods between A and B, primarily in urban areas."

Interest in BL has grown steadily in many countries after ca. 2010, especially in Europe (see cyclelogistics.eu). Businesses have started to test it out, public sector has supported different trials, and there has been academic interest in the topic (Amstel et al. 2018, Lenz & Riehle 2013, Leonardi, Browne & Allen 2012). The academic focus has, however, been somewhat narrow, as the literature review in the next section will show. Research has been technological and atheoretical, not paying much attention to the role of social and planning aspects of BL.

I will therefore look at BL from the planning perspective, incorporating theories that analyse technological changes from societal viewpoint. One such theory is the multi-level perspective (MLP) (Geels 2012, 2019). MLP talks not only about the technology, but of socio-technical systems and socio-technical transitions from one system to another. Transitions from one system to another are socially situated, and not just a question of new and objectively "better" technology or innovation. Having a

multi-level perspective on transitions involves three levels: socio-technical landscape, socio-technical regime, and niches (Geels 2012).

In many cities around the world, cycling is a small market niche (or what Geels 2012: 473 calls the "subaltern regime") next to the dominant regime of the car. In Copenhagen, however, cycling has a relatively prominent presence both when it comes to infrastructure, but also in modal share (see KK 2021). Cycling can be seen as one socio-technical system next to the one of the car, having its own supporting regime including planning.

Cargo bike as a private means of transport for moving kids, groceries and pets around is well established and acknowledged also in planning: the Bicycle Strategy (KK 2011) mentions for example the need for better cargo bike parking. In 2020, there were 24 800 private cargo bikes in Copenhagen, which is 33% more than in 2016 (KK 2021: 29). Somewhat paradoxically, considering the popularity of private cargo bikes, there are no political goals about business done on bicycles or about transition to larger market share for BL. One of the main aims of this thesis is therefore to investigate how municipal bicycle planning relates to BL and to the needs of social groups related to BL.

Using bicycles for some form of goods delivery is according to Cox and Rzewnicki (2015) almost as old as the bicycle itself, but bikes specifically designed for commercial goods delivery have been used since around 1880s. They have been used for newspaper and mail distribution, by bakers and grocers, as well as by street vendors. From 1970s, the cargo bike re-emerged as means of personal transport in for example Denmark and the Netherlands, but lost importance as commercial delivery vehicle.

However, steadily more cargo bikes used for freight are seen on the streets of Copenhagen. There are different actors in the field of BL: courier services, small bike-only delivery companies, Danish or regional logistics companies that use bikes in addition to other vehicles, and big international logistics companies that also have incorporated bikes in their fleet. Additionally, bikes are used in service sector either by small service providers as their main means of transport (e.g. plumbers), or by bigger companies as part of the fleet (e.g. SOS Autohjælp). Smaller producers of goods within the city can also use bicycles to deliver their products to customers (e.g. FungaFarm mushrooms to restaurants). Moreover, the Capital Region is using bikes to collect blood samples from general practitioners' offices.

Even though BL is not very widespread yet, there is interest in the topic. On 27th of August 2021, Danish Cyclists' Federation, the City of Copenhagen, and Capital Region organised a conference in Copenhagen City Hall, bringing together bicycle producers, logistics companies and their customers, service providers using bikes, business organisations (Dansk Industri, Dansk Erhverv), politicians, and planners.

BL has the potential to be more sustainable than conventional logistics, reduce congestion, air and noise pollution, and improve urban liveability, but there are also potential conflicts with other infrastructure users. The diversity on the cycle tracks is on a rise. In addition to regular bicycles, there is a growing number of electric bicycles, electric unicycles, cargo bikes, electric cargo bikes, electric scooters, mopeds, and now also freight cargo bikes with up to four wheels. The capacity of bicycle

infrastructure does not rise in the same tempo as the diversity and that might cause conflicts, especially when new faster and heavier bike types meet inexperienced cyclists, elderly people, or children.

This poses a dilemma for planning authorities that both have responsibility to help the city meet the climate goals, but also to provide good service level for city's many everyday cyclists and be the best cycling city in the world. Both business interests and private persons commuting to work and school are part of the city, and should be planned for, but are their interests conflicting or is this just an unjustified fear? And are there planning tools that would help to solve these potential conflicts?

Pronello, Camusso & Valentina (2017) compare the needs and opinions of retailers, transport companies and decision-makers (based on URBeLOG project initiatives in Naples) and conclude that the actors are not aware enough of each other's needs and therefore the planning for logistics lacks a holistic perspective.

The existing computer modelling oriented research on BL needs a broader planning perspective to supplement it. This broader perspective should take into consideration the social aspects of emerging technologies and transitions from one technology to another, as well as the plurality of actors and their needs in the planning process. Written withing the Nordic Urban Planning Studies (NUPS) framework, this thesis will look at BL from the broad planning perspective, examining actors and social groups related to it.

This leads to the main research question of this thesis:

How can a transition to bicycle logistics by planned for in Copenhagen?

The question can be broken down into following sub-questions:

- **What is the status of the bicycle logistics niche in Copenhagen?**
- **How do changes on landscape level influence planning for bicycle logistics?**
- **What kind of planning measures are available and how do the relevant social groups perceive the usefulness of these measures?**

The thesis consists of four main chapters. The 1st chapter gives an overview of main directions of academic research on BL. The 2nd chapter explains the theoretical foundations, such as MLP, SCOT, and discusses the role of space and uncertainty in making planning decisions. The 3rd chapter discusses the methods: document analysis and qualitative interview. The 4th chapter provides an analysis guided by research questions. The thesis ends with conclusions and some suggestions for planning.

Chapter 1. State of the art

This chapter discusses the main topics of research on BL to situate this thesis in the field and to point out the research gap. I have grouped the previous research under sub-topics of 1) areas of use and replacement potential, 2) potentials and challenges for BL, 3) business models and economy, 4) sustainability, 5) hubs or mobile hubs, and 5) planning and policy.

1.1 Background

As mentioned, the research on BL tends to be technologically focused and almost atheoretical, albeit with a few exceptions. A fresh Swedish study (Isaksson & Alm 2022) focuses on BL companies and municipal planners in larger cities, also using MLP as the main theoretical framework, supplemented by literature on strategic niche management. The conclusions of their study are similar to the findings of this thesis, although there are important local differences. For example, lack of cycling infrastructure is less of a problem in Copenhagen than in Swedish cities. Some issues are almost the same in both countries, for example following aspects that Isaksson & Alm identify (2022: 7):

> [M]ore work could be done to connect issues of bicycle infrastructure with issues of bicycle logistics. There is also a potential to link urban freight issues, including bicycle logistics, much more clearly to the strategic plans for sustainable urban and regional development (for instance the municipal comprehensive plan and the regional development plan). However, at the moment the responsibility for all these issues (bicycle, mobility, and freight) are divided among different units in the organisation, which makes transformative work fragmented and difficult to implement.

Arnold et al. (2017: 3) have reviewed studies in urban logistics and LML and show that the majority use simulation as their method and consider internal costs far more than external ones. This is also an issue for planning, as BL's main advantages stem from reducing externalities, which makes it hard to make a business case in an economy that does not yet give externalities a price.

According to Bosona (2020), the flow of goods in urban areas is growing. The reasons include globalisation, economic development, population growth, urbanisation, densification, and growing e-commerce. Ranieri, Digiesi & Silvestri (2018) point out several downsides of this process, including increase in greenhouse gas (GHG) emissions, reduced efficiency of transport system, increased space occupation etc. All this makes cargo bikes relevant as a means of goods transport, especially for LML.

Although the negative effects of motorised transport are well-known and well-documented, changes are slow and diesel vehicles dominate. There is, however, a growing interest in transitioning to more sustainable alternatives. Llorca & Moeckel (2021) discuss different options such as electric vans, drones, autonomous delivery robots, and cargo bikes. Van Amstel et al. (2018) use the concept of *light electric freight vehicles* (LEFVs), containing electric cargo bikes, electric cargo mopeds and small car-like electric distribution vehicles.

There is a lot of uncertainty about the future logistics models, and it is difficult to predict which technology will prevail in the future, but this thesis focuses mainly on electric cargo bikes as a means of transport already present in Copenhagen both for private and commercial logistics. This does not exclude the potential for other LEFVs as their spatial and planning needs are somewhat similar, whereas drones and autonomous delivery vehicles are not yet present in the city, and it is unclear if or when they arrive, and in which capacity.

1.2 Areas of use and replacement potential

BL is mostly used and discussed in the context of freight LML but is not limited to that. It can also be used to deliver directly from the producer to the nearby customer and in service sector. Also first mile logistics, that is collecting parcels from private or business customers that need to send something, is a possible field of application.

The substitution rate of combustion engine vehicles with more sustainable alternatives is currently still low and many companies do not see BL as a serious enough alternative to vans, often more due to image than actual technological limitations (Wrighton & Reiter 2016).

A study by Lenz & Riehle (2013) found that BL is mostly used by small or one-person companies or small cycle freight operators, but there are also successful examples of integrating cargo bikes into an existing motorised fleet. They further determined that most of the companies using BL operate in courier, express and parcel (CEP) sector, with the second most common being general transport sector. Also catering, logistics services (warehouse, comprehensive LML concept) and retail are represented. According to their study, 25% of the goods transported in cities and 50% of light goods could be transported by cargo bike.

Van Amstel et al. (2018) assess that 10–15% of the delivery trips in the cities would be suitable for LEFVs. They see market potential in post and parcel logistics, food logistics, construction logistics (for example in completion maintenance phases of construction projects, in which shipments are small and time-critical), service logistics (maintenance, cleaning, installation and repair), and non-food retail logistics.

Wrighton & Reiter (2016), discuss the results of two EU-financed projects, The Cyclelogistics (2011–2014) and Cyclelogistics Ahead (2014–2017). They have a broad view on BL, thinking private logistics in too. Their estimate is that in urban areas on average, 51% of all motorised trips associated with the transport of goods can be shifted from car to bicycle or cargo bike. From this amount, 1/3 is commercial and 2/3 private logistics. Zooming in to commercial logistics, they see 25% replacement potential for deliveries and 50% for service and business. Referring to focus group meetings with small business operators like plumbers, window cleaners, chimney sweeps etc., they argue that there is theoretical potential for cargo bike use in this area, distances and weight of tools considered.

Llorca and Moeckel (2021) used German data and the city of Munich as an example and found that the weight threshold for a parcel to be transported on a cargo bike is 10 kg. Based on this assumption, 55% of the parcels in their study area could be transported by bike.

Melo & Baptista (2017) pose a lower estimation that cargo bikes can replace up to 10% of conventional vans in areas with maximum linear distances of about 2 km. Their study is based on traffic modelling in Porto and has the aim to determine what the market share of cargo bikes (replacing vans) should be to improve the general traffic flow for other vehicle types, which is different than the approach of most other studies.

1.3 Potentials and challenges

Llorca & Moeckel (2021) point out that the advantages of cargo bikes over motorised vehicles are that they are 1) smaller and can more easily ride on narrow streets and find parking spaces closer to destination, 2) do not produce noise or direct emissions, 3) are cheaper to buy and maintain, whereas labour costs remain the same. As a challenge they bring out smaller capacity and limited range, driver fatigue, and lower maximum speed.

Thoma & Gruber (2020) performed an exploratory factor analysis where 389 organisations interested in cargo bikes rated their agreement towards 23 drivers and barriers for BL. The study resulted in three driver factors (soft factors, cost benefits and urban advantages) and four barrier factors (vehicle limitations, worries and perils, riders' concerns, and infrastructure constraints).

Leonardi, Browne & Allen (2012) identified pros and cons of cargo bikes based on a trial conducted in London. Some of the pros of cargo bikes are that they require less kerbside loading space, are easier to manoeuvre in heavily congested situations, can potentially access urban locations closed to motor vehicles at certain times of day, have smaller space requirements for overnight storage, are not usually subject to on-street parking charges or parking fines, are not subject to the charges imposed by congestion charge schemes, do not require driver licensing for the riders, have a positive public image, are likely to be safer in areas with high pedestrian activity and can gain from the increase of transport infrastructure provided for cyclists.

Some of the cons are the limited payload weight and volume, existing supply chains that often involve distribution centres located at the edge of, or outside, the urban area, and the need for implementation of a distribution centre located in the delivery catchment area (ibid.).

Lenz & Riehle (2013) name following motivations for adopting BL: company philosophy, traffic density in inner cities, cost factors, speed in city centres, marketing value, bans or restrictions on motor vehicles in certain areas. Problematic aspects are among others lower capacity and lack of security (theft risk).

1.4 Business models and economic potential

Freight LML is according to Bosona (2020) the most complex, expensive and polluting part of the distribution chain, characterised by involvement of many actors, short routes, low speed of driving, short time of effective driving, long vehicle downtimes, labour intensity, space restrictions, limited traffic infrastructure compared to high demand for transport, inefficiency (low load factor, empty running), high population density, and related high environmental concern. Freight flow is fragmented, smaller vehicles are used, and vehicle capacity is often not utilised fully. This demonstrates the need for alternative logistics models to deal with these inefficiencies.

Business models for BL vary, and there is no single answer to the question if BL is economically profitable. Urban form, legislation, and infrastructure in each city influence the market options available for BL. Many calculations are based on approximations, as the logistics sector is highly competitive and economic data is not easily shared.

LEFV-LOGIC project in the Netherlands (van Amstel et al. 2018) has a broad research approach, looking at vehicle types and characteristics, logistics, design and technology, policy, and scalable business models. While fleets keep growing in some of the cases they analysed, other initiatives have remained small or cannot get off the ground at all. BL does often not match logistics operators' current processes and business models. The planning, sorting, loading, and invoicing of deliveries are more suited to the use of vans and trucks. By analysing actual business cases, van Amstel et al. point out some solutions to these challenges, divided in aspects of distribution network, planning and control, information and communication technology and organisation.

Llorca & Moeckel (2021) bring out possible increase in labour costs as the operations time might be longer, and additional costs for micro hubs. Purchase and maintenance costs for cargo bikes are lower than for the vans, but the number of cargo bikes needed is higher. Bosona (2020) too points out that driver costs might affect cost of the delivery, and cost estimation and planning become more complex due to constraints on cargo capacity, driver working hours, and battery capacity.

Arnold et al. (2017) use simulation to compare both internal costs (costs for the businesses) and external costs (costs for the society). They simulate both current diesel van deliveries, self-pick-up, and cargo bike system in Antwerp to be able to provide basis for decision-making. They conclude that self-pick-up reduces costs for the businesses, but cargo bikes reduce external costs.

1.5 Sustainability

Bosona (2020) points to the need to take both environmental, economic, and social sustainability into consideration when analysing BL. Most of the studies currently tend to focus on either environment or economy.

Some studies, however, do try to take all three aspects of sustainability into account. Clausen, Greiger & Pöting (2016) discuss a pilot project in Paris with three micro depots in different boroughs and cargo

bikes and bring out that CO_2 and particle matter emissions were both lowered 82% and NO_x emissions by 80%. They also mention, as does Bosona (2020), that working conditions became more relaxed for the drivers, employment rate is higher, and introduction to new drivers can be kept short with an intelligent routing system. Bosona (ibid.) brings traffic safety, security, noise, health issues, employee satisfaction, and customer satisfaction out as the social metrics for assessing the sustainability of a logistics solution. Schliwa et al. (2015) name reduction of accidents, reduction of large vehicles, quality of life, and liveability as social goals.

These are all important aspects, but the category "social" seems to be a place for everything that is not directly related to economics and emissions. One aspect completely lacking from discussions of social sustainability is the distribution of space or spatial equity – who has the right to occupy public city space, for what purposes and to what extent? Finding balance between private and business uses of the infrastructure is an important planning aspect.

Environmental sustainability is the aspect where the research can be most conclusive about the positive impacts of BL. Leonardi, Browne & Allen (2012) base their findings on "before" and "after" calculations of a trial in London. Van trips from warehouse outside the city were replaced by feeder trip to urban micro consolidation centre, where smaller parcels were delivered by cargo bikes, and bigger by electric vans. Electricity for both the bikes and the vans came from renewable sources and the total CO_2 equivalent (including carbon dioxide, nitrous oxides, and methane emissions) fell by 54%. This included fall by 49% per parcel delivered between the suburban depot and the City of London, and by 83% per parcel delivered within the City of London compared with the situation before the trial.

Melo & Baptista (2017) have calculated 73% reduction of CO_2 emissions, whereas TNT Express and STRAIGHTSOL project's collaboration (Verlinde, Macharis & Kin 2014) using a mobile hub resulted in 24% reductions in CO_2 emissions and 59% reduction in particulate matter smaller than 2.5 μm.

According to Assmann et al. (2020), combination of trucks (high capacity and consolidation potential) and urban transhipment points (UTPs) is the best when it comes to reducing GHG emissions and beats, at least at hight parcel volumes, conventional delivery system using electric vans. On the other hand, vans (electric as well as conventional) instead of trucks reduce air pollution remarkably, but do not have so high impact on GHGs. Authors suggest choosing a model based on which problem is more acute in a given area.

1.6 Hubs

Several articles mention the need for inner city hubs where vans or truck bring goods in, and where electric cargo bikes deliver them further to the receiver (Lenz & Riehle 2013, Llorca & Moeckel 2021). The hubs are needed to make the BL concept viable, because the speed and capacity of cargo bikes is not suitable for long hauls out of the city.

Bosona (2020) points to the terminological inconsistencies related to these depots or hubs, as they are in different articles called urban consolidation centre (UCC), regional warehouse, (micro)hub, (micro)depot, (micro) distribution centre, local depot, local distribution centre etc.

The terms are often used interchangeably and are indeed often synonymous, but there are also differences in content, as some of the concepts are meant for consolidating goods from different suppliers to reduce the number of delivery trips, whereas others are solely for changing the transport mode (for example from van to a cargo bike). The hubs can be shared by different carriers or be used by one carrier only.

According to van Amstel et al. (2018), a fixed hub in the city (based on Dutch cases) costs 150 000–250 000 euros/year in terms of space and staff (for an area of 250–1000 m^2). The volume of goods passing the hub is an important factor, but it might still be hard to afford a location in the centre due to real estate prices. Some businesses can use their existing locations, a customer's space, or a mobile hub, but there are supplementary options, for example offering storage space to customers, offering a pick-up point service for parcels, sharing a hub with other businesses, and sharing bikes/LEFVs (one business using them during the day, another during the night).

Clausen, Greiger & Pöting (2016) give an overview of INTERREG project LaMiLo (Last Mile Logistics), where different concepts were tested in Paris, Nijmegen, London, and Brussels. Not all the pilots included cargo bikes, but different consolidation options were tested. One option was to use a UCC where goods from different suppliers will be consolidated instead of several independent deliveries. The pilots demonstrated a decrease in total distance travelled and good vehicle capacity utilisation, but there was not enough data to determine whether UCCs are economically viable in the long run. One of the pilots in Paris made use of micro distribution centres, small facilities held by only a single carrier. These serve as a transhipment platform to which the goods are delivered by large vehicles and where they are portioned into smaller loads. Finally, the goods are delivered to the dense urban zones using light vehicles.

Assmann et al. (2020) discuss UTPs in cities. They argue that though there is a large body of research demonstrating the viability of UTPs in dense areas, there is limited knowledge about planning them. Municipalities must provide land for essential infrastructure, but urban planners lack guidelines for defining the suitable candidate locations. The study presents a quantitative scenario-based model that assesses the impacts of a UTP on a district. In their study, UTPs are not used for consolidation, and can be cooperative or belong to a single operator. In case of cooperative UTPs the facility needs to be stationary, but singular UTPs can also be semi-stationary or mobile. The authors focus on external impacts of delivery, and not on expenditures and revenues, as this data is not available.

In addition, or instead of a stationary depot, many studies consider the viability of mobile depots, defined as a bus, truck, barge, or a tram that circles the city and connects to low emission last mile delivery options (Arvidsson & Pazirandeh 2017) or as a trailer fitted with a loading dock, warehousing facilities, and an office (Verlinde et al. 2014).

1.7 Planning and policy

According to Bosona (2020), three major dimensions of urban planning affect the efficiency of LML. These are built environment (with attributes such as population density), planning control (a system dealing with parking, loading, and unloading issues), and transport control (a system dealing with speed limits, traffic lights, bus lanes, railway crossings, etc.). Historical centres, population density, different restrictions and regulations for motorised transport, narrow streets, lack of loading and unloading spaces and difficulty for adapting infrastructure to growing freight volumes are all affecting LML but can create favourable conditions for BL. On the other hand, growing BL is also met with planning needs: road infrastructure is often inadequate, infrastructure for charging is missing, there are capacity constraints, and lack of cargo (de)consolidation centres. Bosona (ibid.) also points out that urban planning concepts like "compact city" are not good at taking LML into account and do not address challenges related to loading space or restrictions to vehicles.

Wrighton & Reiter (2016) bring out a range of measures cities and regions can apply to promote BL. Indirect means can be restrictions on motorised transport (access restrictions that are based on time, emission factors, weight, etc.) and general speed reduction. Direct means include providing more/better cycling infrastructure, and incentives and funding for BL. Furthermore, municipalities can use BL themselves (for street cleaning, park maintenance, inter-departmental transport etc.) and favour BL in own procurement.

Van Amstel et al. (2018) point to LEFVs as emission-free alternative compatible with car-free cities, but there are also questions and resistance. There are safety concerns and questions of where these vehicles should drive, load, unload, and park, and cycling infrastructure is at some places already congested. Some fear that LEFVs block the sidewalks, and neither traffic regulations nor infrastructure are mostly not yet ready for LEFVs. There are different roles for the municipality in this process. They can stimulate, regulate, facilitate, coordinate, or experiment.

Schliwa et al (2015: 56) conclude that local authorities need to harness the potential of BL and provide conditions that incentivise private companies to integrate BL into their supply chain through public–private partnerships. This includes measures affecting material infrastructure, nonmaterial infrastructure (integration across different companies), equipment (e-assist deregulation), as well as urban governance (for example zero-emission zones and reducing drive-through traffic). They claim that efficient integration of sustainable logistics would not only support the decarbonisation of urban freight transport, but also gives an opportunity to increase the overall quality of life as well as the smartness and competitiveness of a city.

This thesis supplements the literature by taking a closer look at the societal aspects of the emergence of BL, the needs of social groups concerned, and planning measures available for the public sector.

Chapter 2. Theory

This chapter discusses and establishes the theoretical framework and main concepts of the thesis. To connect technological developments, social changes and planning, I have chosen to bring in the MLP, social constructivist approach to technology, and discussions on how both the existing space, but also the uncertainty of future affect planning for transitions.

2.1 Socio-technical transitions and the multi-level perspective

The theoretical backbone of this thesis are the socio-technical transitions and the MLP, introduced through the writings of Frank W. Geels. His approach gives a holistic view of the transition process, considering both the role of the technology (such as emergence of electrical cargo bikes) as well as wider changes in society. Although MLP is more known from the field of innovation studies and mobility, it has a lot to offer to planning theory, too.

According to Geels (2012), the socio-technical approach sees transport systems as a configuration of elements including technology, policy, markets, consumer practices, infrastructure, cultural meaning, and scientific knowledge. Major shifts in these socio-technical systems are called socio-technical transitions. Transitions are long-term processes with many actors and social groups involved. The elements in socio- technical systems are also maintained, reproduced, and changed by various actor groups like companies and industries, policy makers, planners and politicians, consumers, civil society, engineers, and researchers.

Geels (ibid., 472) points out how MLP can help analyse the dynamics of stability and change:

> On the one hand, existing systems are characterised by stability, lock-in, and path dependence, which give rise to incremental change along predictable trajectories. On the other hand, radical alternatives are being proposed, developed and tried by pioneers, entrepreneurs, social movements and other relative outsiders (to the existing regime). These alternatives typically face an uphill struggle against existing systems, because they are more expensive (since they have not yet benefited from economies of scale and learning curves), require changes in user practices, face a mismatch with existing regulations, or lack an appropriate infrastructure. The core puzzle in transitions thus centres around (dynamic) stability and (radical) change, and how the interactions are played out on multiple dimensions.

In other words, Geels argues that there is a constant dynamism in the system, and even though new alternatives start in a weaker position, they keep challenging the dominant technology.

Geels (2012) sees transitions as non-linear processes that are the result of the interplay of developments on three analytical levels: niches, socio-technical regimes, and an exogenous socio-technical landscape. The levels increase in stability and can be seen as a nested hierarchy.

Geels argues that *niches* are where the novelties emerge. They are often "protected spaces", for example subsidised projects and experiments. Niche actors work with radical innovations that differ from the

current regime, but they hope that their innovations will become a part of the regime or even replace it. BL can be seen as one of the niches in comparison to the established logistics sector.

Socio-technical regimes are, according to Geels, the deep-structural rules that coordinate and guide actors' perceptions and actions. It is important to notice that socio-technical *systems* and socio-technical *regimes* are not the same. *Systems* are made up of alignments between technologies, policies, user patterns, infrastructures, and cultural discourses. Its elements are reproduced, maintained, and incrementally improved by actors such as firms, engineers, users, policymakers and regulators, and special-interest groups. *Regimes* are the shared rules and institutions that shape the perceptions and actions of these actors. Geels (ibid.: 473) explains the difference by calling "systems" tangible and measurable, and "regimes" intangible rules that actors draw on. Geels (2019) also points out that innovation in existing systems and regimes is mostly incremental and path-dependent because of various lock-in mechanisms: these can be techno-economic (sunk investments and vested interests, low cost and high-performance of existing technologies), social and cognitive (routines and mindsets, social capital), or institutional and political (existing regulations, standards, and policy networks, vested interests). Especially the institutional and political mechanisms are strongly related to planning.

Current diesel-based city logistics – as a part of the general "system of automobility" (see Urry 2004) – can be seen as the dominant socio-technical system with its supporting regime. As mentioned, cycling has a regime of its own in Copenhagen, but that as a means of personal transport and not so much for goods transport.

Socio-technical landscape includes both slow-changing developments like demographics, cultural repertoires, societal concerns, geo-politics, macro-economic trends, and external shocks like wars, financial crises, accidents, oil price shocks (Geels 2019). In other words, landscape consists of the ways the society influences technology and technological transitions. It is a two-way relation: some transitions would simply not be possible without certain technological innovations, but some technological innovations would never have happened without landscape pressures that guided interests and resources in certain direction.

Geels (2019: 190) suggests that

> [T]ransitions come about through the interplay between processes at niche, system, and landscape levels. Although transition specifics vary between domains and countries, the general multi-level dynamic is that: (a) niche-innovations gradually build up internal momentum, (b) niche-innovations and landscape changes create pressure on the system and regime, and (c) destabilization of the regime creates windows of opportunity for niche-innovations, which then diffuse and disrupt the existing system […].

Planning can speed up the transition by actively supporting the niche and creating a regime around the niche, but planning can also be strongly rooted in the old regime supporting the dominant system.

Geels (2019) divides *socio-technical transitions* into four main phases. First, there is experimentation and trial-and-error learning with radical niche innovations. In this phase there is much uncertainty, competing claims and high rates of failure and pioneer burn-out. Geels points to current sustainability and urban experiments, local projects and living laboratories, but also to their challenges with fragmentation and isolation form one another. Green niche innovations also face challenges like being more expensive than existing technologies, uncertainties about markets and users, as markets are not "ready" for them, and issues with legitimacy and acceptance due to being new, strange, and unreliable.

In the second phase, innovations have established themselves in one or more market niches and acquire a "dominant design".

In the third phase, innovations diffuse into mainstream markets. This is driven by both niche-internal as well as landscape-related developments. Inside the niche there might be improvements in price or performance, the technology can be scaled up, complementary technologies develop, and there will be support from powerful actors. Landscape developments can pressure the regime, leading to tensions and regime destabilisation, and provide structural windows of opportunity for niche innovations.

There is no guarantee that niche innovations win this competition, but if it happens, the new socio-technical system replaces (parts of) the old one in the fourth phase of transition. (Geels 2019)

Geels (2012) discusses the automobility regime and brings out both destabilising and stabilising landscape pressures that it faces. He brings out climate change, Peak Oil, and information society as destabilising pressures. But there are also many stabilising aspects such as cultural preferences for private property, speed and time saving, the physical landscape (cities are shaped by the motorised transport and planning has followed the spatial needs of the car for a long time), association of car with freedom, choice, progress, wealth and status, economic growth that enables buying cars, and increased demand for mobility in globalised and networked society.

2.2 Uncertainty and space

Architect and researcher Robert Martin (2021) has applied MLP to link sustainability transitions in transport with spatial thinking. He discusses spatial strategies for the transition towards sustainable urban mobilities in his PhD thesis written in cooperation with JaJa Architects, using among others the niche of autonomous vehicles as an example. His point of departure is the rejection of "predict and provide" approach that dominated transport planning for a long time and oftentimes still does. According to Martin, decision-makers are not well-equipped for planning in the situation of increasing uncertainty where the accuracy of forecasting decreases. Talking about autonomous vehicles, he points to difficulties of predicting if, when, and to what extent a new technology will enter the field.

In Martin's words (ibid., 19):

> Traditionally, governmental land-use and transport-planning authorities have been responsible for the implementation of new transportation systems. However, these institutions face significant challenges. These include confusion surrounding the technological readiness of new mobility technologies, growing concern about the accuracy of modern transport-planning tools, and lack of knowledge of how cities should transition towards new technologies and best utilise them to meet sustainability targets.

He proposes a possible future scenario for sustainable urban mobilities system in Copenhagen. His aim is to investigate how architectural thinking and architectural ways of working can contribute to sustainable mobilities. His scenario is about the mobilities system in general, and not specifically about BL, but there is clearly a place for BL in his proposal. This thesis does not work with architectural tools, but Martin's use of MLP and his focus on the spatial dimensions of mobilities have been a great inspiration. He also points to the need of active decision-making about what kind of cities and future we wish to see. Both the urban space we are living in and the transport technologies we are using are socially constructed, and the way we conceptualise space directly affects the ways we create the built environment. Sustainable transitions are needed around the world, but each transition has its own spatial context.

Martin analyses the car reduction strategies of several European cities (Oslo, Ghent and Barcelona). His argument is that urban environments are often designed around car use and support unsustainable mobilities, but the emerging niche technologies do not yet exist on a scale that makes it possible to analyse how the spatial features shape their use. Looking at the cities that are trying to implement car-free or car-low solutions helps us see which already existing spatial characteristics can contribute to sustainable mobilities. He found that the ultimately car-centric infrastructure of the past can often be used for car-reduction in the future, as many cities are using their surrounding ring roads or tunnels as the starting point of restrictive measures like toll ring or low-emissions zones. This is the case for Oslo and Ghent where the car-free strategies are based on ring roads, whereas the superblocks in Barcelona are based on wide avenues built in mid-19th century for horse traffic.

Lyons & Davidson (2015) delve into transport planning and policymaking in the face of an uncertain future. They point out that globalisation, economic instability, climate change, technological innovation and changing consumer preferences are increasing the uncertainty of outcome that decision-makers are facing. There are different levels of uncertainty, ranging from relatively predictable future through alternatives with different probabilities and several plausible futures to unknown future, also characterised as "deep uncertainty". Deep uncertainty suggests that there may be fundamental societal changes or "regime transitions" on the way, and car travel is one of the areas where this is the case. Desirable transition from one regime to another can be brought about through transition management and active planning.

If decision-makers realise that they are shaping the future and not just responding to predictions, the uncertainty might become an opportunity. Lyons & Davidson outline two policymaking pathways: regime-compliant, and regime-testing. The first one implicitly relies on the world as we know it and

assumes that the same tendencies continue. Uncertainty is concealed, and the car regime is assumed to go through an evolution rather than a transition. The second pathway embraces deep uncertainty and considers transition a possibility. This does not mean that the current regime *cannot* continue, but rather that we cannot rely on it continuing. Regime-testing pathway brings with it an opportunity to shape the future. In this way, "predict and provide" is replaced with "explore, decide and provide".

2.3 The social construction of technology

Another interesting approach relevant to BL is social construction of technology (SCOT) as advocated by Pinch & Bijker (1984). They apply the principles of social constructivism and extend it from the study of scientific knowledge to the studies of technology and technological artefacts. Interestingly, one of their examples is the development of a bicycle.

According to Pinch & Bijker, crucial role in the development of every technology is played by the social groups concerned with the artefact. What they define as the relevant social group can be institutions and organisations (such as the military or an industrial company), as well as organised and unorganised groups of individuals. The requirement is that members of a certain social group share the meanings attached to a specific artefact, but one must be attentive to how long a group can be seen as homogenous and where does a new group start. They illustrate it with an example of the bicycle: a group called "cyclists" was not enough, because when women started to cycle, their needs, attitudes and problems differed from the ones of the classical "sporty" male cyclist. Groups opposing a technology are also relevant to the development of this technology, for example the "anti-bicycle" segment in the early days of cycling. The identification and description of a social group needs to be detailed enough to avoid unproductively broad categories such as "producers" and "consumers". For different groups there are different "problems" with the technology and different solutions grow out from these problems, resulting in multiple branches of development, some of them more successful than the others.

Pinch & Bijker discuss different phases in the research program. First there is the phase of interpretative flexibility of a technological artefact, but not only in how it is thought of, but also flexibility in how it is designed. Secondly, after a longer process, stabilisation follows. Flexibility diminishes and the process results in a design that most people think of when a certain technology is mentioned (for example, air tires and wheels with an equal size are taken for granted when talking about a bicycle nowadays). The third aspect of research is relating the content of the technological artefact to the wider socio-political milieu.

The technological artefact of BL is the electric cargo bike, but the urban logistics model containing hubs can also be seen through the lens of SCOT. The aim of this thesis is not to conduct a sociological analysis of the development of cargo bike designs or any specific technology that made the electric cargo bike possible, but it is important to point out how the already existing cargo bike has innovated to solve current problems and meet the needs giving rise to the BL concept. As Mackenzie and

Wajcman (1985: 12) propose: “new technology then typically emerges not from flashes of disembodied inspiration but from existing technology, by a process of gradual change to and new combinations of that existing technology.” The development of cargo bike referred to in the introduction is a good example of this. Cargo bike is old, but it is the combination with electric assist that makes the technology of BL new.

Rosen (1993) has further developed SCOT while also providing relevant criticism. His analysis of the social construction of mountain bikes brought out that although Pinch & Bijker wanted to bind together the micro-level of technology with the macro-level of society, their way of doing it did not go far enough and remained too technology-centred, with social aspects being a topic for the future. Secondly, Rosen points out that though SCOT stresses the importance of relevant social groups, the analysis of these groups has not been far-reaching and rich enough. Thirdly, SCOT did not pay enough attention to relations between the different social groups and the social arena for the construction of technology created by these interacting groups. Fourthly, Rosen found that the notion of stabilisation in SCOT can be problematic, as not all technological artefacts stabilise in the way originally described by Pinch & Bijker.

Chapter 3. Methods

This chapter gives an overview of the methods used in this thesis. The primary method is interviewing, supported by document analysis as background method.

3.1 Document analysis

Document analysis has been used to review municipal planning documents in relation to BL and cycling in general. The aim was to identify if and to what extent BL is incorporated into the planning and how it differs from general bicycle planning. As the discussions around BL point to topics such as climate, environment, mobility, liveability, and economy, it was important to look at planning documents more widely, and not only plans and strategies directly related to cycling or logistics.

Extensive desk research was also conducted around companies using BL and Danish legislation concerning it.

3.2 Interview

The main data collection method was qualitative semi-structured interview. The method was chosen because it enabled gathering case-specific data (about planning for BL in Copenhagen). In-depth interviews with key actors were preferred to a survey to see motivations and reasonings behind the expressed standpoints, rather than receiving a yes or no answer.

Brinkmann (2013) argues that even though neither completely structured or completely unstructured interviews are possible, it is still productive to distinguish between more and less structure, with semi-structured interview being somewhat in the middle. This is according to him the most widespread interview type in social sciences, as it gives an opportunity to follow up angles deemed important by the interviewee. It also makes the interviewer visible as a knowledge-producing participant and helps to focus the conversation on issues relevant to the research project.

Brinkmann (ibid.: 37) also distinguishes between receptive and assertive interview styles. Interviews conducted for this thesis were of a more receptive character and were treated as research instruments (rather than social practices).

Six interviews were conducted (five in person, one via video call), with:

- Tanjamaria Ballhorn, project manager in the Green Mobility team in Copenhagen municipality (29/03/2022)
- Torben Damgaard Nielsen, co-founder of Chainge, a Danish BL company (01/04/2022)
- Stefan Attig, hub and fleet manager for Velove, a Swedish BL company that also manufactures cargo bikes (01/04/2022)
- Trine Stig Mikkelsen, manager of Cykelvæksthuset under Danish Cyclists' Federation (21/04/2022)

- Casper Svensson from City Logistics, a Danish logistics company and consolidation services provider with electric fleet containing a limited number of cargo bikes (04/05/2022)
- Anna Lassen, bicycle planner in Bicycle Programme team in Copenhagen municipality (04/05/2022)

The original intention was also to interview larger logistics companies that combine cargo bikes with a fleet of vans/trucks, but despite several attempts to contact them via e-mail, phone, and some office visits, the persons deemed relevant either did not reply or were unavailable. As a consequence, first-hand data is lacking about the differences between companies with cargo bike/electric fleet only, and companies combining diesel fleet with bikes.

Events dedicated to BL, the conference on 27/08/2021 and the seminar at Vejdirektoratet on 09/05/2022, were also important sources of knowledge for this thesis.

The SCOT concept of social groups (as discussed in previous chapter) was a guideline in choosing companies and organisations. Several groups with interest in BL can be named: pure BL companies, logistics companies combining electric fleet with bikes, conventional logistics companies that use bikes in addition to diesel vehicles, business customers buying service from BL companies, private customers receiving deliveries, municipal planners, politicians, everyday cyclists in Copenhagen, Danish Cyclists' Federation (standing for all cyclists' interests, so representing both BL and everyday cyclists), car-drivers in Copenhagen, bicycle manufacturers etc.

The aim here is not to fully describe every group that may have some interest in BL, but to focus on the groups that are most relevant from planning perspective and whose representatives were interviewed for this thesis. These groups are BL companies, municipal planners, and the Cyclists' Federation.

My student assistant position in the municipality helped determine the relevant interview subjects there. Finding the interview subjects from the companies was based on online research, looking through the participant list of the BL conference in August 2021, and LinkedIn searches to find the right people in companies. Company representatives were contacted first via e-mail or in one case via LinkedIn.

Interview guides were prepared for different groups of interview subjects: one for municipal planners, one for companies, and one for Danish Cyclists' Federation. Each type of interview guide was then adjusted to some extent before the individual interviews to match the context. For example, when interviewing a person that was familiar from my workplace, the question about her background was omitted. For company representatives, some questions might have been omitted if the answer was already known from background research. Interview guides served as a backbone to keep the conversation going and make sure the relevant topics were covered, but in some cases the order of the questions changed if the interviewee touched upon the topic earlier. Occasionally additional questions were asked as follow-up.

Interviews were conducted in English or Danish based on agreement. Torben and Stefan were interviewed in English, others in Danish. Interviews were recorded after gaining permission from the interviewees, and the interviews were later transcribed. Hand-written notes were taken during the interviews to avoid loss of data in case of technical failure. The transcripts were coded with a combination of concept-driven and data-driven coding (Brinkmann 2013: 62), where some codes were based on previous literature and some from the interview data itself. For the interviews in Danish, I translated the quotes used in the next chapter.

Chapter 4. Analysis

This chapter discusses the research question and its three sub-questions in the light of my theoretical framework and empirical data. Discussing the first sub-question, I show that BL can be seen as a niche, competing against the established regime and other niches. Turning to the second sub-question, I argue that landscape pressures related to climate and environment influence the logistics sector and might influence planning for BL. The third sub-question is discussed by exploring planning measures relevant for BL and giving an overview of how the representatives of the different groups perceived the relevance of these measures.

4.1 Bicycle logistics in Copenhagen – the niche and the regime

This section discusses the status of the BL niche in Copenhagen, arguing that BL can be conceptualised as a traffic niche, though cycling as such constitutes a regime. I am drawing on municipal plans and strategies, interviews with companies, planners, and Danish Cyclists' Federation.

Planning for bicycles

Cycling was an important mode of transport in many European cities, including Copenhagen, around 1900–1950 (Agervig Carstensen & Ebert 2012). Since then, it declined everywhere, but unlike many other cities with very low current modal share, cycling in Copenhagen has managed to survive and go through a revival since (see Gösling 2013).

I argue that cycling is a regime in Copenhagen for several reasons. It is perfectly normal to have a bike, there is a well-developed infrastructure for cycling, and cycling is well-established in the city's planning. In 2020, Copenhagen had 632 300 inhabitants and 736 600 bicycles (KK 2021: 8), so the number of bicycles in the city exceeds the number of people. 2016–2020, bicycle ownership increased 9%. The number of electric bicycles increased 148% 2016–2020, and the number of privately owned cargo bikes increased 33%, making it to 24 800 cargo bikes (ibid.). Academic research also convincingly demonstrates that cycling is a normal everyday practice in Copenhagen and not specific to any certain social group (Gössling 2013, Larsen 2017, Freudendal-Pedersen 2015).

Going through Copenhagen's plans and strategies for urban development and mobility shows that cycling, as well as green mobility in general, is thoroughly written in, and there is also a dedicated team for strategic bicycle planning. The municipality is striving for a holistic approach that sees climate, environment, liveability, mobility, and city's functions in relation to each other. In addition to dedicated bicycle strategy (KK 2011), goals about cycling go as a red thread through other planning documents such as the Climate Plan (KK 2012a), Action Plan for Green Mobility (KK 2012b), the Co-create Copenhagen vision (KK 2015) and and the Municipal Plan (KK 2019). There are also separate prioritisation plans for cycle tracks and for bicycle parking (KK 2017, 2018a). There are goals about the modal share, network of extra-wide cycle tracks, travel time, safety and perceived safety, and citizen's satisfaction with bicycle parking, maintenance of bicycle infrastructure and cycling's effect on city life

(KK 2011). The progress with achieving the cycling goals is monitored in the annual Mobility Report (*Mobilitetsredegørelse*) and biannual Bicycle Account (*Cykelregnskab*).

However, there is also a regime of the car. Copenhageners owned 132 200 cars in 2020 and the rise in car ownership 2016–2020 has been 12%, exceeding the increase in population (7%). Although bicycles dominate the numbers, cars dominate the space. According to the municipality's own mapping (ibid.: 9), all infrastructure related to cycling takes up 10% of the space between buildings, whereas road space and car parking together take up 54%. Cars also dominate the total modal share (all trips to, from and in Copenhagen) with 31% in 2020 against 26% for cycling (ibid.: 6).

Cycling can be conceptualised both as a dominant sociotechnical regime or as a subaltern regime existing in parallel to the dominant one (Geels 2012) – depending on whether one sees driving or cycling as the main mode of transport in Copenhagen – but cycling is long-established and stable enough not be called a "niche".

The BL niche and the diesel regime

Commercial bicycle *logistics*, however, can be seen as a niche, although the idea of transporting things on a bike is not new. The reason for defining BL as a niche, a location for radical innovations at the periphery of existing systems (Geels 2012: 189), is that conventional logistic based on diesel is dominating the market, bicycle deliveries or services by bike have a small market share, there is no single established concept or business model, and it is lacking a supporting regime. Planning in Copenhagen caters for cycling as such, and BL can use the existing cycling infrastructure, too – however, looking through the city's plans and strategies and interviewing two municipal planners showed that BL is largely not planned for (yet). There are no political goals about BL, it is not mentioned in infrastructure prioritisation plans, and the city does not have any initiatives to directly or indirectly support BL. The only mention is in the Bicycle Strategy (KK 2011: 14) where it is stated that by 2025, "cargo bikes will be an integral part" of the city's logistics system.

Cargo bike for business purposes is not, as Cox & Rzewnicki (2015) demonstrate, a new thing, but electrically assisted cargo bikes can be considered a "radical innovation" in the current logistics system. Radicality here is not understood as a sudden finding of something that has never been seen before (bicycle and cargo bike as well as electric batteries have existed for a while). Rather, radicality is seen in the context of the dominating system and in the degree of deviation from it. Geels (2019: 190) categorises the innovations into technical, social and grassroot, business model or infrastructural innovations, and brings some mobility-related examples. He argues that battery-electric vehicles are a technical innovation, bike clubs or modal shift to bicycles/public transport are grassroot and social innovation, mobility services and bike-sharing are business model innovation, and re-development of public transport is infrastructural innovation.

BL fits under several of these categories identified by Geels. Turning cargo bikes into battery-electric vehicles is a technical innovation, as are containerisation solutions, routing software adapted to bikes etc. Having hubs for redistribution in the inner city and several companies sharing a hub can be

considered a business model innovation, although it also has an infrastructural aspect. Infrastructural innovation could be bicycle streets or measures that improve flow for cyclists.

It would also be possible to talk about policy innovation. This would be the case if policymakers took the first step and created a framework that boosts a niche movement or even starts one. This fits well with Lyons & Davidson's (2015) "explore, decide and provide" approach introduced in chapter 2.

Niche innovations in MLP can be compared to the interpretative flexibility in SCOT (Pinch & Bijker 1984) as discussed in the 2rd chapter. I argue that BL is currently in this stage of interpretative flexibility, both when it comes to cargo bike designs and business models, but also to the possibilities of what can be carried (or done) by bike.

Diesel-based vans and trucks are the dominant socio-technical system for goods transport in Denmark and Copenhagen. According to Gudmundsson (2020: 4), 99% of the 42 000 trucks in Denmark still drive 93% on fossil diesel oil. Transport is an old and well-established business, supported by others (car manufacturing, fuel producing, road construction, gas stations, warehousing services etc.). The socio-technical regime supporting this system is in place as well. There are institutions and regulations as well as the "common-sense" understanding that if a bigger number of things needs to be moved, it inevitably happens by car.

The words of interviewees from BL companies confirmed that BL can be conceptualised as a niche, opposing the current regime of diesel-based logistics. Stefan Attig from Velove says:

> I think it's so early days. The bike businesses are I think less than ten years old. It's an old concept, but it's very new at the same time.

When talking about the conventional logistics, Stefan used expressions like "in stone", meaning that logistics is an established industry that is very hard to change. Torben Damgaard Nielsen from Chainge called it a "diesel-driven economy" where transitions are not happening without outer pressures, as buying greener vehicles is a costly investment. He also says:

> It's just a matter of how strong the opposing lobby is, and they are strong, because they're sitting in the transport business.

I argue that these quotes confirm the idea of a regime that is slow to change, often locked in to path-dependency (Geels 2012).

Neither Stefan nor Torben saw other BL companies as their competitors, but rather as allies, because both Velove and Chainge are carried by a green agenda and a wish to remove polluting vehicles from the cities. As the market share of BL is small, they say there is enough work for everyone.

The niche of BL in Copenhagen does not only mean small bicycle companies. Large conventional transport businesses (DHL, UPS, Bring, GLS) have also started using cargo bikes in small numbers. As it was not possible to interview them, there is no first-hand data about their motivations and challenges but dividing parcels between bikes and vans can be one challenge. As Casper Svensson from

City Logistics mentioned, dividing and planning routes without a proper software is inefficient, and City Logistics had to invest in creating their own. Simple software may assign small packages to a bike and large ones to a van, but if the bike and the van drive to the same location, the small package should also be on the van. According to him, the market does not offer suitable software yet.

During the BL seminar at Vejdirektoratet on 09/05/2022, Rambøll presented the initial results of their report on BL, where they had used data from Bring. Although cargo bikes showed to be more time-efficient during distribution, Bring has decided to prioritise electric vans for deliveries during daytime precisely because the sorting of parcels is manual, it creates extra costs, and has caused duplicate trips with both a van and a bike going to the same place.

Trine Stig Mikkelsen from Danish Cyclists' Federation pointed out that even though the large companies start seeing the value in BL, it demands a lot to redesign their huge apparatus to BL. This allows to conclude that conventional logistics companies that are a part of the regime, but also take part in niche innovations, experience certain practical and business model related challenges that bicycle-only companies do not have.

The regime is inert, and often just makes small adjustments to keep going or even tries to mimic changes without doing much. Both Torben from Chainge and Stefan from Velove gave examples where other companies had tried to use their bikes for what they considered greenwashing. In Chainge's case, a diesel-based logistics company that did not use bikes themselves, asked if they could take pictures with Chainge's bikes in order to "look greener". Velove is a bike producer itself, and started out by selling their bikes to others, but after a greenwashing attempt they decided to go into logistics business themselves.

The niche of the EV

There is another niche that competes with the established diesel-based transport: the electric vehicle (EV). This was confirmed by the interview with Casper from City Logistics. In Casper's view, the applicability of BL to replace diesel vehicles is narrower than the BL companies expressed, but part of the reason might be that City Logistics works with a different business model than Chainge and Velove. BL companies deliver to the end customer (on behalf of another company like Budbee, Aarstiderne or Simple Feast) or deliver smaller products such as fruit boxes to businesses. City Logistics handles bigger volumes such as municipal procurement for certain municipalities and offers added value by reducing the number of deliveries by consolidating. In this way, volumes increase, and according to Casper, the practicality of cargo bikes decreases.

The niches of EVs and cargo bikes can be complementary, but they can also compete if carrying out tasks suitable for both. Whereas the market share of non-diesel trucks is still below 1% (Gudmundsson 2020), the number of registered new electric vans is growing (Klosterskov Perkild 2022).

Electrifying the fleet is almost automatically seen as sustainable transition in the media and among decisionmakers, as EVs do not directly emit GHGs or pollutants while driving. It is, however, often left

out that the lifecycle of an EV is not emissions-free. Pipitone, Caltabellotta & Occhipinti (2021) demonstrate that global warming effects of an EV are roughly 60% of an equivalent internal combustion engine vehicle, but the production phase is critical, and may have a strong negative impact on terrestrial acidification, particulate matter formation, and mineral resource deployment due to lithium battery production. Battery production requires several metals and the main producer, China, has a coal-dominated electricity mix. They also point out that savings in global warming effect during use of an EV only occur in case the electricity comes from renewable sources. If electricity comes from for example coal, EVs may easily become the most polluting vehicles.

Electric cargo bikes also have emissions from production and the electricity consumed, but significantly lower compared to electric cars. Narayan and Antoniu (2022) point out that the energy consumption of electric cargo bikes ranges from 9 to 18 Wh/km, whereas e-van consumes around 200 Wh/km and e-truck 800 Wh/km. Direct comparison, however, is difficult, because usage areas of cargo bikes and trucks are often different. With vans, direct substitution might be possible, but not always. Though competing in some cases, BL needs goods to be transported into the city (the so-called feeder trips). Interviews with BL companies show that they prefer these feeder trips to be done by EVs instead of diesel vans or trucks. There will also always be goods that are not suitable for bicycle delivery, but greater use of cargo bikes would still be preferred, as electric vans/trucks do not solve issues with congestion or competition over the scarce city space.

To conclude, BL can be conceptualised as a niche in Copenhagen, as opposed to the established system of conventional logistics with diesel vehicles. It is however important to note that cycling as such is not a niche, but rather a regime in itself. While cargo bikes used for business logistics are not new, vans have pushed bikes to the background for decades when it comes to goods transport. Innovations such as electric assist, logistics hubs, new business models, new bike designs and materials, and software solutions have started to bring the cargo bike back into the picture as a serious means of goods transport but it still faces an uphill struggle and must compete with the regime as well as the niche of EVs. Niche innovations of BL may, however, receive support from increasing pressures that the socio-technical landscape exerts on the regime. The next sub-chapter will discuss these landscape pressures in more detail.

4.2 Landscape pressures and planning

This section discusses how changes on landscape level influence planning for BL, drawing on the interviews and the concepts from MLP and SCOT.

As discussed in the 2nd chapter, socio-technical landscape is according to Geels (2012) the wider context around socio-technical systems. The SCOT research program (Pinch & Bijker 1984) also relates technological development to wider socio-political milieu and stresses the need to study these relations. This “wider socio-political milieu” is in many ways parallel to the landscape level of MLP.

Issues with climate (GHG emissions and global warming) and environment (air and noise pollution, loss of biodiversity) are obvious pressures for the regime supporting conventional diesel-based logistics. Copenhagen aims to be CO_2-neutral in 2025 (KK 2012a), but road transport is increasing and so is its share of total emissions, even though the vehicles get slightly less polluting (KK 2021: 15). In 2017, 460 Copenhageners died due to air pollution (KK 2020: 5).

Another important landscape pressure in Copenhagen is related to liveability and public space. During the recent decade, Copenhagen has been on top of several indexes listing cities based on liveability, sustainability and green transport, and this international image has become something that the city's governance relates to (Simpson 2018). The Co-create Copenhagen vision for 2025 (KK 2015) states that the city should be liveable, responsible and with an edge. Making the city liveable includes better everyday life in urban spaces, city for cyclists, and more urban nature. As it says in the vision (ibid.: 5): "Urban spaces need to be arranged to accommodate a greater number of everyday activities. The city must be hospitable and clean, and it must be easy to get to where you want to go." These goals do not fit well with a constant flow of trucks and vans. Traffic is also a place of conflicts. One of the main types of traffic accidents with casualties is a cyclist or a pedestrian getting hit by a truck or a bus, often when the motor vehicle turns right (KK 2018b).

On the other hand, there is a need for goods and services in the city, and for many, the density of available goods and services might be the reason to live in the city. The share of e-commerce and related parcel delivery is on a rise, though still making up a smaller part of the total goods transport in the city (Gudmundsson 2021: 24-25). The COVID-19 pandemic has probably accelerated this rise, although it is too early to see its long-term impact. COVID-19 itself can be seen as a landscape pressure from the category of "external shocks". People order more online, including goods that would have been bought from the physical store before, for example groceries. Landscape pressure of growing e-commerce is two-sided, leading to more deliveries and more vehicles, but also putting pressure on the logistics sector to be greener and more innovative.

Another external pressure whose impacts on BL remain to be seen is the war in Ukraine and the rising energy prices that might potentially increase the attractivity of cargo bikes for delivery and make BL more affordable as fossil fuels get more expensive.

As the importance and urgency of green transition grow, it will be more prominent both on the national and the municipal agenda. The question is, what is the municipality's role in relation to BL? On the one hand there are political goals and the need to act, and the sustainability advantages of BL are relatively well documented (Leonardi, Browne & Allen 2012, Melo & Baptista 2017, Verlinde, Macharis & Kin 2014). On the other hand, BL is private business, and it can be argued that public money should not support the delivery of people's (in many cases unsustainable) online purchases, even if the last mile delivery method itself is sustainable.

The interviews with the businesses showed that they see themselves as a solution to emission and pollution issues by directly replacing diesel vans. Torben from Chainge has worked with sustainability

and green transitions in different ways and could list specific numbers for CO_2, NO_x and particulate matter reductions compared to if all the routes Chainge has cycled would have been driven by vans. He also stressed the importance of social sustainability. In his words:

> We are coming from sustainability. But we're also coming from a… let's say non-Wolt model. We are not having an approach where we are not hiring our people. We have contracts, they are paid by the hour, they are insured by us to run our vehicles, bikes in this case, and that is also a costly model when you're competing against somebody that is not running that model. So yes, it's a challenging field. But if you want to change something, you need to take the first step.

Having both environmentally and socially sustainable business model makes it harder to compete with companies that go for the lowest price, but according to him, Chainge does not compete to be the cheapest, but rather provides the customer with a sustainable solution. His opinion was also that the conventional logistics sector only changes when forced to and often does not take climate issues into account in their operations.

Stefan from Velove expressed similar standpoints, saying that aspects like ecosystem services do not have a price in our economy, and the added value by a more sustainable solution does not have a direct monetary equivalent. Congestion or emissions also don't translate into anything when setting a price for the delivery service, so paying for it remains customers' free choice.

There are different opinions about what is the role of the planning in promoting green transitions. Both Torben and Stefan expressed the need for public authorities to support BL. Stefan referred to the new types of cargo bikes that are bigger and can in some cases replace a van one-to-one, taking into consideration that delivery vans with small parcels are not always optimally filled. Companies with cargo bikes help mitigate emissions and traffic issues, so planning should be more supportive of that and take these new bike types into consideration.

Torben argued that green transition in Denmark needs to be sped up, and the public sector has a big role in that:

> If we want to have a nice place to live over the next 100 years, we must do something different. That's clear. And that's where the municipality also comes into the picture. They must take a big step, instead of small ones. I know that we are a big city for biking and a lot of people bike, but the car congestion in Copenhagen is ridiculous. And you can do so much more. The one primary thing for a company like ours is location, we need access to spaces where we can operate that doesn't cost 1000 or 2000 or 10 000 or 15 000 kroner per m^2 per year. It's money that does not exist in this area. So we need to have some sort of municipal backup or state backup that promotes what we do. There are almost 300 subsidy programs in the EU that are directly targeted towards bikes and cargo bike implementation, both private and public. And we don't have anything in Denmark.

Casper from City Logistics argued that the municipality should take a leading role and make a transition to green deliveries in their own procurement, showing that they as a customer are willing

to pay for the sustainable solution. For this, green delivery should weigh more in municipality's tenders, but it also needs to accept that green transition costs.

Danish Cyclists' Federation was also supportive of BL and Trine gave examples of how the federation is trying to facilitate progress by consulting businesses through the Cykelvæksthuset project. The Cyclists' Federation is also somewhat impatient over the slowness of the progress and wishes that the state and the municipalities would create a framework that makes it easy to choose green and healthy solutions. Trine admitted though that there might be legal barriers that she is not aware of.

Interviewees from the municipality, Tanjamaria Ballhorn and Anna Lassen, were also both positive about BL and acknowledged its potential in relation to climate, environment, and congestion, but were more reserved about the municipality's role. Tanjamaria pointed out several limitations that the municipality has, some legal, some related to the diversity of companies using BL, and some merely related to lack of data. She saw the municipality's own procurement as the most important tool, both by setting requirements and by being in dialogue with the market about what they can do, both when it comes to using bikes or for example electric trucks, the latter not being widely available yet. Tanjamaria also pointed at differences in the needs of businesses: big international companies like DHL and UPS are financially able to help themselves and do not really need support from the municipality. Small bike-only businesses might need that more, but the municipality has no legal means to differentiate between them.

One topic in the interviews was also (potential) conflicts in whom to plan for. BL companies are just one, and still relatively small, segment of infrastructure users, and while the companies stressed their part in solving many of the landscape issues pressuring the current logistics regime, both the municipality and the Cyclists' Federation mentioned possible conflicts between different cyclists, and the importance to not favour any specific group.

It can be concluded that landscape pressures on the logistics sector are strong, but the branch in general is very competitive, price-sensitive and inert, so the regime resists. Awareness of the landscape-level issues is however strong among the BL companies, municipality, and Cyclists' Federation alike. All interviewees agreed that planning should take these pressures more into account, but there were differences in what exactly can and should be done. Planning for BL is currently marginal in Copenhagen, but there is interest in facilitating the transition. Both the municipality and the Cyclists' Federation see themselves more in facilitator's role, whereas the BL companies ask for a more active and direct action from the public sector. Everyone agrees that the approach to physical planning might need revising soon, too, but there is no common understanding as to how. The next sub-chapter will take a closer look on the specific planning solutions that might be relevant for BL and discusses them in relation to different user groups.

4.3 Planning for bicycle logistics – measures and needs

This chapter explores what kind of planning measures are available and how the relevant social groups perceive the usefulness of these measures. The measures that were included in the interview guides stem both from the literature review and from the municipality's current plans, but interviewees were also invited to name measures themselves. The aim was to see, to what extent are these measures perceived as needed or applicable in Copenhagen's context. I have divided the measures into direct support, traffic and infrastructure, and legal and policy measures.

4.3.1 Direct support

Direct support is defined as all measures directed specifically at BL to give it advantage over diesel-based logistics. As discussed in chapter two, subsidising or providing help with hubs are both ways for the public sector to directly engage with BL.

Subsidies

The are no subsidy programs for BL in Denmark, neither on the municipal nor the national level. There are examples from other countries, like France (see https://colisactiv.city/), where companies participating in the subsidy program get money from public funds per delivered parcel on the condition of sharing data with the subsidy program. That makes their services cheaper for the customer, which in turn increases the volumes and helps the companies to grow and stabilise. As Stefan from Velove expressed it, "this business is a volume game", meaning it is hard to be profitable if the volumes are not big enough. According to Geels (2012: 472), niches can be "protected environments", such as publicly subsidised demonstration projects to support certain innovations, but the BL niche in Copenhagen does not receive this kind of "protection" from harsh competition.

BL companies call for an active and value-based approach from the public sector. Torben saw the lack of subsidies as a local issue in Denmark:

> That is a Danish problem. Almost every country in Europe has local, regional, and national subsidies for bikes. It's just Denmark that doesn't think that it is possible. And to be honest, I think we are just not too smart about it. Other nations are smart about it. And we're missing a great opportunity in reducing CO_2 emissions in cities.

Casper from City Logistics provided a different perspective and is opposing subsidies, as he does not see it as the public sector's task to support customers getting their goods; the market has to solve the issue on its own and find more sustainable business models. He saw, however, the municipality in a facilitating role, for example by dedicating some locations for micro-hubs and saying that all parcel delivery in that area must go through these hubs. The companies should however rent the hub on market terms and should not receive any subsidy, as it is the customers who have to accept that sustainable delivery has a price. BL, for him, has not found a viable solution for this value creation yet. He pointed out that different European BL projects run on subsidy for a limited time and stop when the subsidy stops.

Hubs

Hubs are the most recurring topic in relation to BL, both in the academic literature (see the 1st chapter) as well as at branch events and in the interviews. All companies say that it is difficult to find suitable locations for a hub due to real estate prices and availability. During the BL seminar at Vejdirektoratet, representatives of logistics companies also brought out planning as a barrier: more and more areas in the city will be filled with privately owned apartments, which makes it harder to find a place for logistics business. It was mentioned that zoning to incorporate logistics activities could be planned in to new urban developments from the start, naming Jernbanebyen as an example.

Currently, there is no shared hub solution in Copenhagen. Everyone is operating on their own: Chainge from Nordvest and Islands Brygge, Velove from Nordvest and Amager, DHL has a facility on Nørre Voldgade with good access to Inner City, Bring operates their bikes from Syndhavn etc. Companies that have both vans/trucks and bikes use the hub in the city only for bikes and have bigger facilities outside for other parts of the business. Hub situation for smaller companies is often somewhat precarious, as Chainge's Nordvest location that used to be a start-up hub for green food-related business is closing soon and Velove is renting one of their locations from a storage space provider, which makes it more expensive as there is one more service provider in between.

Both BL companies would be interested in and open to sharing hubs with others, and Chainge even has other companies ready and willing to sign a contract together as soon as a suitable facility appears. Both Torben and Stefan said that their need for space varies and is highest when the goods are brought in to the hub, but it would be possible to coordinate between the companies. Stefan also demonstrated the rack solution Velove has for their bikes, where the bikes are hung up instead of taking up floor space.

Large companies have their own complicated logistics chains which might make sharing more difficult. Both Tanjamaria and Trine also mentioned differences between the companies. Trine pointed out a difference in mentality and approaches, saying that big companies would prefer a larger and permanent logistics facility with option for freezing and cooling, whereas small BL companies are also open to trying something out "quick and dirty". Cyclists' Federation themselves would prefer getting started and testing concepts out before investing into permanent solutions.

When talking about the type of the facility, both Torben and Stefan preferred an already existing building. Stefan stressed the importance of being on ground floor. Parking garage is an option too, but height (can a van or a truck enter with goods?) and working conditions create issues. Stefan saw help with finding a location more crucial than any other direct means of support:

> For us, I would say it's more finding locations. Subsidies we could make use of, but we're more interested in finding better places. Sometimes these places are not very nice. If we have an underground parking lot, it's dark, it's not a place for people to be in, and it's cold. The main thing we need is toilets and facilities, but it's really hard to find good places. Especially ground level

> with enough space. Usually, it's down, and many things are not available. So we check every month.

BL projects in Europe have used container solutions (see for example https://www.komodo.berlin/), but Torben was not too positive about this solution. He says:

> I've seen the one in Prague and others like that, using containers is saying that it is temporary. So, if you want to do anything about this, you have to stop thinking like that, get out of the container, move into a real location and start operating a real company. Having 2, 3 or 4 containers doesn't do anything whatsoever. We have looked into containers, if we're setting up anything, we'll be looking at somewhere between 12 and 20 containers plus a 200 m² tent to receive stuff in, but that's the last resort. When we have locations downtown that are not being used for anything, why not look into that? We can also have a look at all the public property that is all over Copenhagen and use some of the space that's not utilized.

The interviews show that the BL companies are very flexible and open to different kinds of solutions, but there are barriers which are difficult for them to overcome alone. Tanjamaria stressed though that legal options for the municipality to support are currently very restricted:

> I am not allowed to do that. How far one can go is a grey area. Let's imagine that a bike was invented yesterday. And that no-one has ever built a hub before. In this case we could make a public–private innovation partnership with those that invented the bike and those that invented the hub. But the bike has been invented. The hub has been invented. It is not an innovation, so I am not allowed to. No matter how much I would like to, I can't.

Tanjamaria also stressed that the municipality cannot do anything that could be interpreted as entering transport business. It is also not possible by current legislation to differentiate between the businesses according to their different needs.

This is confirmed by a report on green city logistics (Copenhagen Electric 2021: 35–37) that assesses municipalities' options for supporting cargo bike hubs, and concludes that the municipalities cannot, according to local authority mandate (*kommunalfuldmagt*), establish or manage hubs for private companies, nor provide municipal facilities for these hubs, as this would mean either operating a business or illegally supporting business activity. Municipalities can, however, provide targeted support to hubs in relation to legal municipal tasks concerning infrastructure, traffic management and environment. This would mean that even though the municipality cannot establish a hub, it can support some of its activities related to municipality's core tasks and goals. The municipality should in this case follow up on how the support is used, and receiving the support can affect the receiver's right to earn profit, which can be a significant limitation. The report also points out that local planning pays very little attention to the need for distribution centres in the cities.

When talking about the business model of a shared location, Torben suggested a model where a starting group of some companies share the bill together. That would mitigate the risks and make it easier to pay the deposit. This core group would run the depot as a community and possibly take in other interested companies. Another option is that someone rents the space on their own and sublets

to everyone else, but that includes taking the risk alone and finding the renters. During the BL seminar at Vejdirektoratet, the KoMoDo project in Berlin was introduced which had an external operator, because the hub was shared by main actors in the logistics business where the competition is strong, and a neutral operator was needed.

Another question was how many hubs would be needed to cover Copenhagen. According to Stefan, each hub should not be further than 15–20 minutes from the destination. Three hubs placed as a triangle or four as a diamond shape would be enough to cover the city. Torben saw the combination with micro hubs as the most optimal. That would mean 5–8 locations in Copenhagen with 5–10 bikes per location. Riding distance from each hub to destination would be between 0,5–2 km. High route density was named to be the key. When asked about the mobile hub, he preferred having a permanent structure due to better working conditions, for example water and toilets. As a supplement to a bigger hub, a permanent container solution as a micro-hub could be an option. As a downside, having several smaller hubs complicates the logistics, as the goods must arrive on time and each location needs a hub manager or a responsible person. To have several locations, the turnover for each location should be big enough to make it economically viable.

To sum up, hubs are one of the most important topics related to BL, directly affecting the viability of the business model, but also a topic where the needs and possibilities of actors differ the most.

4.3.2 Traffic and infrastructure

Followingly, I discuss aspects of infrastructure that are relevant for BL and identify the specific needs of BL within the general bicycle planning. It was of special interest in this section to discuss some of the municipality's current bicycle planning tools (like wider cycle tracks for main traffic corridors and implementing more bicycle streets on secondary cycling network) from the viewpoint of BL and to see if the same measures serve everyday cyclists and BL alike. Interviewees were also asked to name aspects of infrastructure or traffic management that are lacking.

Wider cycle tracks

This measure is relatively uncontroversial and would serve private cyclists and BL alike. The city of Copenhagen has a goal in the Bicycle Strategy (KK 2011) of building out the PLUS-net, a selection of main cycling arteries with higher requirements for width and maintenance. 80% of the chosen cycle tracks should be improved by 2025, but the progress has been on a standstill and currently only 20% have been improved (KK 2021). An example of PLUS-net track with larger capacity is Nørrebrogade. Stefan brought that out as a very positive example where freight bikes and regular bikes can pass each other without problems. Torben however argued that since Nørrebrogade is an extremely busy street for cycling (as is Østerbrogade), their couriers actually avoid it during rush hours and try to use side-streets. Width of cycle tracks was occasionally a challenge according to both Stefan and Torben, but they stressed that they instruct their couriers to always be polite and avoid any conflicts with other cyclists. Torben also brought out the need for general change in priorities and reallocating the space from cars to bikes.

Bicycle streets

Copenhagen has applied for funding to create more bicycle streets, a concept for streets with high bicycle traffic where there are no separate cycle tracks, but cars are allowed as "guests" and the traffic should flow on cyclists' premises (see Bruno 2020). Currently Vestergade in the Inner City is a bicycle street, and the redesign process is about to start on Nordre Frihavnsgade, but potentially there will be more. Bicycle street concept could potentially serve BL if faster electrical cargo bikes are allowed to use the whole road space and more easily overtake slower cyclists without creating uncomfortable situations. Stefan was positive about bicycle streets as these would leave an option to drive a car if needed but give cyclists a clear priority and affect the liveability of the streets positively. Torben expressed being generally open to all initiatives favouring bicycle traffic over motorised traffic. He saw, however, a danger that a car-driver with higher speed would drive into a group of cyclists, so it would be necessary to make sure that drivers know and follow the rules. He saw great value in turning some streets into bicycle-only streets, where cars are allowed to cross the street (giving cyclists priority) but would not be allowed to drive along it. Such streets could create quick access corridors through the city.

Tanjamaria was also positive about more bicycle streets and pointed it out as one of the main planning measures to look at to give more space to all the different types of cycles. The Cyclists' Federation too was generally appreciative about the concept, especially from the viewpoint of BL, but pointed out similarly to Torben that there might occur dangerous situations and that it takes time to get all road users to respect the new solution. Both Tanjamaria and Trine mentioned the need to give more space to cyclists where they dominate the numbers, but also to reallocate the space based on who we wish to have more of in the future.

Anna Lassen from the Bicycle Program said, however, that the current infrastructure planning does not yet take BL into consideration as a separate group. This means that the pros and cons of infrastructure solutions will be analysed from the viewpoint of everyday cyclists, but not necessarily the riders of freight bikes.

Access restrictions for cars (emission zones, toll rings etc.)

Not surprisingly, bicycle companies would welcome more differentiated access rules that favour greener modes of transport. Stefan brough pedestrian street Strøget out as good example of traffic restriction (no other traffic than delivery allowed, and even that only during certain times), but currently it also creates a detour for the bikes, so an option would be to consider always allowing delivery on a bike. Torben pointed to the need for car restriction on a wider scale, for example closing downtown to cars running on fossil fuel, having carpool lanes on the highways etc. Not all these wide-scale measures can be implemented by a municipality though.

Tanjamaria saw the need to set the restrictions based on how much the different vehicles emit. She predicted that the mindset will be less car-centric and more focused on urban life in the future, but at

the same time allowing necessary traffic in low-emission vehicles. Anna, too, agreed that certain access by car needs to remain.

Roadworks, bollards, public events

Both BL companies named different practical matters that sometimes make life difficult for bicycle delivery. According to Torben, roadworks do not take the big cargo bikes sufficiently into account, leaving too little space for them to be able to pass. Another issue is quick cleanup after roadworks, as there is often gravel and flints on the streets that cause flat tires. He also named big events like Ironman, marathons, and upcoming Tour de France that close the access completely in certain areas. He did not see events a problem as such but would like to see solutions where bikes have certain times and places to get through. Chainge delivers a lot during Sundays and events affect their work quite much. Leaving some access options for bikes would be a way to support BL and give cycling priority over car traffic.

Stefan pointed out that certain measures for restricting car access are also restricting big bikes. Worst solution according to him are the so-called slalom gates (also called chicane), with barely enough space for a regular bike to manoeuvre through, and impossible to pass on a freight bike. He said that sometimes it is even necessary to remove the container from the bike and slide it through under the gate, but it is difficult to get the container back on. Classical bollard solution (wide enough for all bikes but narrow enough to keep the cars out) is the best in these situations. Generally, he was positive about restricting car-access physically (if the solution is functional) because this gives a competitive advantage to bicycle delivery.

Such practical details were only mentioned by the BL companies, as they are the ones with first-hand experience of the issues. Roadworks and access barriers at times only taking regular bicycles into account proves that BL has not yet found its way into the planning. The issue is wider, though, concerning the general increased plurality of vehicles on cycling infrastructure, also the private cargo bikes.

4.3.3 Legal and policy measures

This section gives an overview of legal and policy-related aspects of BL.

Planning and political goals

As mentioned, BL is not directly incorporated in any of the plans and strategies of the city, except for the procurement requirements. Both planners were open for increased focus and inclusion in the future. Both the Climate Plan and the Bicycle Strategy expire in 2025 and it remains to be seen to what extent the targets will be met and what will happen afterwards. Anna was positive about including BL in the future Bicycle Strategy in case there will be one. It is also a possibility that a more integrated mobility strategy will replace the separate plans. Tanjamaria mentioned an application for EU, where, in case of a successful outcome, several cities would go together to make a SULP (sustainable urban logistics plan) and put a focus on solving the lack of data issue.

City's own procurement

This was seen as one of the main policy tools by several interviewees. According to municipality's presentation at the BL conference 27/08/2021, the municipality buys for 8,2 billion DKK yearly, and goods delivery for the municipality creates 4,5 million km driving each year. In 2019, City Council decided that requirement for green vehicles must be included in the city's tenders. Green vehicles were defined as cars driving on electricity, biogas or hydrogen, or plug-in-hybrids. Also other, non-motorised vehicles such as bikes are considered as green vehicles. The same presentation also referred to city's new climate plan for 2035 (voted through in 2021) that contains a goal of reducing CO_2 from public procurement 50% by 2035.

Tanjamaria also pointed out procurement and the ongoing market dialogues with the companies the city buys from, but stressed that it is important to find the places where BL fits in. Municipal procurement often includes big amounts of goods where replacing trucks with cargo bikes is not realistic.

Both Trine and Casper saw a potential to do even more through procurement, though. Trine named setting specific requirements for bikes in some tenders, whereas Casper talked about fossil-free delivery in general and said that the municipality as a customer also must be willing to pay for green transitions. He gave examples of smaller municipalities like Roskilde and Lyngby that already buy electric delivery and consolidation service from City Logistics. At the seminar in Vejdirektoratet, participants also expressed the need to weight bicycle delivery/fossil-free delivery higher in the tenders.

Legislation

Defining what a bike is and where it must be placed on the road according to the laws was discussed with most of the interviewees. In the budget agreement for 2022, Copenhagen's City Council decided to reduce the speed in the city for 10 km/h on most roads, expect big traffic arteries, by 2025. In that relation, interviewees were asked if the freight bikes could potentially be on the road instead of a cycle track when general traffic flow is slower. Especially Tanjamaria and Trine were positive about this idea, taking into consideration other, slower cyclists. The Cyclists' Federation is interested in potentially dividing the road space according to speed and not by vehicle type. Anna was more reserved, stressing traffic safety and saying that electric bikes are generally not so much faster than the regular ones. Torben expressed the need and interest to test this solution in real life but mentioned that it takes some time for their bikes to reach their average speed, so when mixed with cars, the bikes could slow down the general traffic flow somewhat. Stefan said that they would choose being on the road if the regulations allowed it. He compared Copenhagen to Velove's operations in Stockholm where there are more painted cycle lanes and less kerb-separated cycle tracks. It is easier to overtake slower cyclists on a cycle lane, but he stressed that there are pros and cons, as cyclists are better protected on an elevated cycle track. Everyone agreed though, that mixing vehicle types can only be an option after

the general speed goes down, and it was also stressed that this solution would need further analysis before making decisions.

In addition, Stefan expressed the need to revise the legislation defining what a bike is:

> So that legislation is kind of outdated in a way because it caters to old design logic. It means we have length restrictions, which could be helpful [to be removed]. We have a double-decker or what we call the semi-trailer. In Copenhagen we're only allowed to ride with one single box. But then we have the one that is more like a double-decker. This is better to compete with the van. This is more, I would say, federal level laws, but I imagine cities could have some say like to test it out would be great because there are also special needs. We have, I'm not going to say the name of the company, but basically, they work with elderly people or elderly care facilities. And one of the jobs is taking up dirty laundry and giving them clean laundry. But in a box like this, it's a bit hard because clean laundry is very flat. But once it's dirty, it's in the bag and it's big. So if you have two boxes, you can separate or provide these services that a van is technically better at doing because they just have the space.

Danish Cyclists' Federation is also open to revision in this question but stresses the need to take all cyclists into consideration. With Trine's words:

> I think it could be reasonable to revise. It could be reasonable to look at exactly this kind of things, like if you can do it in Sweden, the Netherlands, Germany, if you can have a trailer attached for the ones that have to move or when there is a little wine shop that has to ride with 20 boxes of wine. In these cases, I think it makes sense to revise, but we have to always keep in mind the atmosphere on the cycle tracks, weaker cyclists, and that everyone has to be able to be there.

According to Tanjamaria, this should be seen in relation to where the bikes ride. If they are on the cycle tracks, there should be restrictions to how wide they are, but if they ride on the road, the restrictions could maybe be changed.

Both the municipality and the Cyclists' Federation are concerned about the potential overcrowdedness and conflicts between different types of cyclists in the future but agree that there is not enough information about this topic yet. Bicycle companies said that they have mostly experienced positive feedback and a lot of curiosity on the streets. They also stress that they train their couriers to always be considerate in the traffic. Torben said:

> Because we are dependent on a positive narrative. And we don't want to be put in the same category as the electric scooters were, because they were a nuisance to people, because they were all over the streets and blocking and all that, people zooming in and out on the walking path as well. So it's important for us not to be looked at as a problem, because we are actually part of the solution. And we do that by having a positive attitude to everybody around us. We see a lot of people who think it's a good idea. And especially when they understand that we've removed the diesel van that would be standing outside in their street with an engine on while the delivery is happening. So yes, they think it's a good idea. We have had a person or two saying, hey, are you allowed to drive on the bike path? And yes, we are. Bikes are approved and they are following European rules. So we fit in the framework.

When asked if the conflicts could appear when BL reaches a bigger market share, he answered:

> Not really, I mean, you can just say, okay, if we put 1000 bikes in Copenhagen, and spread them out all over the place, you wouldn't be able to see the next bike when you stand on the street. They blend into the picture. So that is not a problem whatsoever. Especially if you then at the same time remove the 1000 vans from the picture, then there's less, not more. So no, that's not a problem.

It can be concluded that there are some considerations on the public sector's side that BL companies have a clear answer to, but the data is lacking when it comes to other citizens. It is upon future research (that the Cyclists' Federation hopes to be able conduct) to ask other user groups on the cycle tracks about their opinion directly.

Tax measures

A topic that surfaced, but mostly remains out of scope for the municipal planning, are tax measures based on climate, environment, or other values such as liveability. These are usually decided on a national level and can include differentiated VAT or special taxes aimed at polluters. A problem that prevents BL from growing faster and having a stronger business case is that environmental impact is still not included in products' or services' prices but remains an externality that no one pays for (which means that everyone will pay for it collectively). This is similar to plant-based foods often being more expensive than animal products or train tickets being more expensive than flying: reduced emissions do not necessarily translate into greater economic competitiveness. The solution here is what could be called "internalising externalities", that is by law incorporating emissions into all prices, thereby giving a competitive advantage to cleaner companies/products.

It can be concluded that the BL niche can be planned for in different ways and there are important measures in all three categories, but hubs, taking larger bikes into consideration when planning infrastructure, municipal procurement, and focus on the size and placement of the cargo bikes on the road gained importance in the interviews. Next chapter sums the findings up and makes some suggestions for the planning.

Conclusion and suggestions for planning

This chapter answers the main research question: "How can a transition to bicycle logistics be planned for in Copenhagen?". As argued in the introduction, research on BL has been relatively focused on calculations and modelling but has been lacking the social sciences perspective. This thesis contributes to research on BL by bringing in the perspectives of MLP and SCOT. These perspectives are productive for planning theory too, casting light on the role of planning in relation to technological niche innovations, dominating regimes and wider discussions in the society. As planning can acquire different roles in different places, and both challenge and strengthen the dominating regime, Copenhagen was chosen as the case and context of my inquiry. Even though municipality is the main planning authority for bicycle planning in Danish cities, it quickly became clear that planning for BL includes different groups of "planners". Municipal planners work within the political framework decided by the City Council, but can propose solutions to the politicians, whereas some initiatives can only be decided on the national level. The policy recommendations at the end of the discussions are also directed to these different levels of planning.

In the introduction, I demonstrated that transport of goods is responsible for a large share of road traffic emissions and is posing a challenge to climate goals both on the municipal and national level. I introduced the concept of BL as one of the sustainable solutions, especially for LML, but also to an extent for service tasks and for general cargo. I established that even though cycling is an integral part of planning in Copenhagen, there hasn't been any real focus on BL, even though it is getting more and more attention on the EU level with subsidy schemes and test projects.

In 1st chapter I gave an overview of the main topics of research in relation to BL, discussing among others the usage areas and pros and cons of BL. I concluded that a large share of the previous research is simulation-based and provides an essential baseline, but there is a knowledge gap in how BL relates to wider processes in the society and to planning decisions, and how these can either encourage or discourage the transition.

In 2nd and 3rd chapter I designed a research approach composed of theoretical framework and qualitative data collection methods. My theoretical approach is relating technological changes with planning, consisting of the MLP as advocated by Geels, the social constructivist view on technology as proposed in SCOT, and the concepts of uncertainty and space discussed by Martin and Lyons & Davidson. Empirical data was gathered by document analysis and qualitative semi-structured interview. Six persons were interviewed to understand the needs of the social groups related to BL. Three of them were from companies, two were municipal planners, and one a representative of Danish Cyclists' Federation.

The analysis chapter established BL as an emerging niche and discussed it in relation to the existing regime of diesel-based logistics, but also in relation to the regime of everyday cycling and the competing niche of electric vans and trucks. Both the analysis of planning documents and the interviews confirmed that cycling is well planned-for in Copenhagen, but the niche of BL is not yet

integrated into municipal planning. Secondly, I discussed wider issues that affect the regime of logistics, such as climate crisis and environmental problems, conceptualised by Geels as landscape pressures. These landscape pressures might open a window of opportunity for BL, although there are other pressures that can support the dominating regime (the rise in e-commerce). The interviews demonstrated that BL companies have a sustainable agenda, and both the municipality and the Cyclists' Federation are very positive about BL, even though more data is needed on how BL might affect the overall bicycle traffic in the city. It can, however, be concluded that the niche of BL is not protected enough by the public sector. Lastly, specific planning measures that can help the transition to BL, were discussed. These measures can be divided into 1) direct support, 2) traffic and infrastructure measures, and 3) legal and policy measures. It can be concluded that direct support measures are lacking due to legal restrictions the municipality has, even though support for establishing hubs is the most urgent need for BL. Infrastructure measures that are good for cycling in general are mostly beneficial for BL too, but BL should be considered more when making planning decisions. BL also has some specific needs related to the size of the bikes (important when planning roadworks and access barriers for cars). Legal and policy measures are relevant both on the municipal level (strategies and political goals, more ambitions procurement strategy) as well as the state level (giving the municipalities more power in planning questions such as zero emissions zones or toll rings, reviewing the national legislation concerning cargo bikes).

Based on the above, a transition to BL in Copenhagen can be planned for by pursuing a more regime-testing policymaking pathway (Lyons & Davidson 2015) when it comes to logistics, but also traffic management more generally. Public sector's own climate goals and environmental and liveability targets should weigh more and be a guideline for political decision-making. A holistic set of measures would be most beneficial, but the challenge is that the measures above belong under different jurisdictions. Some measures are most relevant for planners (guidelines for roadworks and bollard design, proposing infrastructure solutions and planning initiatives), some for municipal politicians (setting goals and targets, making ambitious decisions guided by landscape pressures of climate and environment), and some for state-level authorities (revising legislation about what the municipalities may decide on, revising national legislation for cargo bikes).

I will conclude with some planning suggestions for different authorities based on my findings.

- The lack of hubs/suitable spaces for hubs is the main limitation to further development of BL. As the municipality is restricted by local authority mandate (*kommunalfuldmagten*), direct support for hubs is currently not possible, but it is worth investigating if the legislation gives a chance for targeted support in relation to municipal tasks (such as traffic management and environment). The legal nuances and practical applicability of this option are however still unclear, and in the longer run it might be needed to revise the local authority mandate so that it would allow the municipalities to be more proactive in supporting climate-positive measures.

- BL should be treated in planning as an independent sub-system of cycling with certain spatial needs. This should not mean prioritising business activity over citizens, but rather finding solutions that serve all cyclists (like wider cycle tracks or bicycle streets). Several of Copenhagen's plans and strategies expire in 2025 (Bicycle Strategy, Climate Plan, Cycle track prioritisation plan) and when looking ahead, BL should be taken into consideration more, preferably by setting political goals for it. This can happen in cooperation of municipal politicians and planners.
- In addition to strategic level, BL should be planned for on a day-to-day operations and maintenance level in the city. Current solutions for cycling during roadworks are not always suitable for cargo bikes and some solutions for car-restrictions unintendedly restrict big cargo bikes as well. BL could also be thought about more when planning big events.
- BL as an option is already written into municipal procurement strategy, but the municipality could be even more ambitious by setting bicycle delivery as a requirement where it makes sense and weigh green delivery proportionally higher in tenders.
- More data about BL is needed, both about the logistics itself and about interactions on the cycle tracks. Both the municipality and the Danish Cyclists' Federation are aware of the lack of data and are working on it, but more dedicated resources would help to gather data faster. Resource allocation is a decision made by politicians on the municipal as well as on state level (for example Cykelpuljen).
- National legislation concerning freight bikes should be revised, both when it comes to the properties of the cargo bikes themselves, as well as their placement on the road. It is too early to conclude whether the legislation should be changed, but data and tests of different solutions would be needed to find out what the consequences would be.
- National legislation should give the municipalities more freedom to establish sustainable traffic management solutions, including car restriction measures such as road pricing and zero emissions zones.

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