Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Engineering
Department of Civil and Environmental Engineering

Johanne Lægran

Urban freight transport data - Identification of potential and implications of collection and analysis of carrier data

Master's thesis in Civil and Environmental Engineering
Supervisor: Trude Tørset and Kelly Pitera
June 2021

NTNU
Norwegian University of Science and Technology

Johanne Lægran

Urban freight transport data - Identification of potential and implications of collection and analysis of carrier data

Master's thesis in Civil and Environmental Engineering
Supervisor: Trude Tørset and Kelly Pitera
June 2021

Norwegian University of Science and Technology
Faculty of Engineering
Department of Civil and Environmental Engineering

NTNU
Norwegian University of
Science and Technology

Preface

This master thesis is written by Johanne Lægran during the spring of 2021 and is the final work of a two-year master's degree. During the fall of 2020 a pre-project was conducted (7.5 study points). The pre-project resulted in a plan for the master thesis, and formed the basis for the master thesis. In the pre-project the major work with the Introduction and State of The Art, as well as the development of the method was done. The thesis is written for Department of Civil and Environmental Engineering at Norwegian University of Science and Technology (NTNU), within the specialization Transport. The workload is 30 ECTS.

Acknowledgement

I would like to thank my supervisors Trude Tørset and Kelly Pitera at NTNU for helping me design the study, obtaining data and guiding me throughout the project. Furthermore, I would like to thank Yngve Frøyen at NTNU for introducing me to the subject and good ideas, and Arvid Aakre for guiding us through a course on how to work with the pre-project. Lastly, I would like to thank Asplan Viak for including me in the Asplan Viak program, and providing me with a scholarship and guidance. I would specifically like to thank Asplan Viak's Øyvind Dalen for providing me relevant information and guidance. Having the opportunity to draw an all of these experts gave me insights to the current status on city logistics, giving me the opportunity to design and execute a project that is relevant for contributing to more sustainable city logistics.

Furthermore, I would like to thank everyone who participated in the project, including those mentioned. I appreciate all of you taking your time to contribute to my research, your valuable insights and your motivational words. Your interest in the project and in helping out was an invaluable motivational factor. I would also like to thank Anne Sofie for providing great help proofreading the document, as well as guidance on qualitative methods and research in general.

Norwegian University of Science and Technology

Trondheim, spring 2021

Abstract

Purpose

Urban freight transport will have an increasing share of the traffic in cities in Norway, as a result of both more restrictions on passenger transport in order to achieve the zero-growth goal and reduce use of private cars, and expected growth in urban freight transport in the future. As any road traffic, urban freight transport contributes to pollution, emission and safety issues. Inadequate infrastructure and unintended effects from measures targeting passenger transport can create a challenging work environment in fact, more urban freight traffic work. The stakeholders responsible for city planning lacks access to data on urban freight transport, which is a barrier for well-planned solutions. A lot of relevant data is being collected by the private actors in the supply chain of urban freight transport, but there is not willingness or methods today to share and utilize this data. The object of this study was therefore to investigate the potential and implications of collecting and analyzing carrier data for more sustainable city logistics. How the collection of urban freight data from carriers can contribute to more sustainable city logistics, has in this study been broken down to four aspects: potential benefits the analysis give actors involved; aspects achieving these benefits would require of an analysis tool; how transport data could be obtained from freight carriers and how it should be collected in order to benefit the analysis; and how existing delivery data sets from carriers contribute to cover the data needs for an analysis tool.

Methodology

This was investigated through conducting interviews on the need for urban freight data among planners/researchers/policy makers, willingness to share data among carriers and the possibilities for automatic extraction from existing carrier delivery data sets. In total, 15 interviews were conducted with 18 interviewees, including ten planners, one researcher, one policy maker and six carriers within three different sectors, namely the grocery, third-party logistics and construction sector. The planners/researchers were mostly based in Trondheim and Oslo, and the carriers and policy maker in Trondheim. Six delivery data sets were obtained, from the same carriers. The data analysis was executed using Excel to get a thorough understanding of the content and format of the data.

Results

The results show that if a thorough understanding of the purpose of an analysis tool is identified, enabling more informed planning and data sharing from the carriers, can provide benefits to both the planning/regulating and operational side of urban freight transport. The planners and policy makers benefit from a data-driven understanding of freight and possibility to evaluate measures, enabling more informed planning and a factual basis for decision making. The benefits seen by the carriers are mostly related to their contribution to enabling the data-driven understanding for the planners/decision makers and increased focus on urban freight transport, and to some degree for their own planning. This is seen to depend on how rigid their transport operations are. The findings also show that the data has to be obtained in line with the carrier requirements, among others: demanding little resources for extraction and processing of data; ensuring anonymization, data security and compliance with market consideration, with a clear purpose for the data use and handling, as well as leading to benefits for the carriers' operation. The data analysis illustrated the view of the literature on how delivery data has to be combined with other data sources to contribute to analyses and urban freight transport indicators. Data on routes, the vehicle fleet and link between deliveries and trips is the most demanded. Furthermore, the data use among the carriers and existing delivery data set show potential for automated data extraction in the future.

Implications/value

This study has found that collection and analysis of urban freight data from carriers can contribute to more sustainable city logistics in the sense that the data-driven understanding and higher degree of cooperation between different actors within city logistics have the potential of reducing negative externalities from urban freight transport and improving the distribution for the carriers, leading to more sustainable city logistics in terms of less environmental impacts, more economic distribution and better health for the inhabitants. This

data-driven understanding and common factual basis for understanding each other's role is important in a complex and conflict-filled landscape of city logistics, and can potentially contribute to an understanding and better solutions for planning and regulation of urban freight transport in the future. Gaining an understanding on how the urban freight transport will be affected by measures, will provide valuable insights on how to reduce negative externalities from the urban freight transport, while improving its efficiency. Knowing what data and functionality urban freight transport analysis tools should have, will enable more targeted development. Furthermore, insights into requirements for stakeholder collaboration by data sharing in city logistics is relevant for others that want access to urban freight data in the future.

Keywords – City logistics, urban freight transport, data, transport analysis, stakeholder collaboration

Sammendrag

Prognoser peker på stor vekst i godstransporten. Trender som urbanisering, økt netthandel og hjemlevering fører til mer kamp om plassen i byene og endring i godstransporten og varestrømmene. Samtidig skal veksten i persontrafikk med bil reduseres gjennom målrettede tiltak og restriksjoner i tråd med nullvekstmålet. Godstransport vil derfor utgjøre en større andel av trafikken i by fremover, og effekten disse tiltakene har på godstransporten vil være større enn den er i dag. En rekke innovative løsninger kan bidra til mer effektiv bylogistikk. Uavhengig av hvilken løsning man skal implementere, er det imidlertid sentralt å gjøre det på en måte som innebærer evnen til å forutsi og estimere fremtidige transportvolumer og effekten av tiltakene på trafikken, inkludert effekten på selve godstransporten. For å være i stand til dette, er pålitelige og høykvalitetsdata om godstransport på byskala nødvendig, for eksempel i en urban godstransportmodell. I dag mangler imidlertid planleggere og myndighetene tilgang på detaljert kunnskap om godstransporten i norske byer. En av årsakene til dette, er at transportører og andre aktører i godsmarkedet er tilbakeholdne med å dele data av markedshensyn. Ny teknologi gjør at godstransportdata samles inn av bedriftene til interne formål i økende grad, som kan muliggjøre effektiv datadeling dersom det gjøres i tråd med bedriftenes betingelser.

Formålet med denne oppgaven er å undersøke hvilket potensial innsamling av godstransportdata fra transportører til analyser har for mer bærekraftig bylogistikk. Dette har gitt følgende forskningsspørsmål for masteroppgaven: **Hvordan kan innsamling og analyse av godstransportdata fra transportører bidra til mer effektiv bylogistikk?** Med følgende underspørsmål: 1) Hvilke gevinster kan analyser av godstransport i by gi for mer bærekraftig bylogistikk? 2) Hva trengs for å forbedre eksisterende analyser av godstransport i by? 3) Hvordan kan og bør data samles inn for å muliggjøre disse analysene? 4) Hvilke muligheter kan leveransedata fra transportører gi for disse analysene?

Gjennom semi-strukturerte intervjuer og datanalyse har dette blitt undersøkt. Planleggere, forskere og beslutningstakere ble intervjuet om deres behov for data, mens transportører ble intervjuet om deres villighet til å dele data og databruk. Dataanalysen undersøkte mulighetene for automatisk datauttrykk fra leveransedata fra de samme transportørene. Til sammen 15 intervjuer ble gjennomført, 14 individuelle og ett i gruppe. 18 personer ble intervjuet, hvilket inkluderte ti planleggere, en forsker, en beslutningstaker og seks transportører innen de tre sektorene dagligvare, logistikk og byggevare. Planleggerne/forskerne var hovedsakelig basert i Trondheim og Oslo, mens transportørene og beslutningstakeren i Trondheim. Seks leveransedatasett ble innhentet fra de samme transportørene. Dataanalysen ble utført ved å bruke Excel til å få en grundig forståelse av innholdet og formatet på leveransedataen.

Resultatene fra studien peker på at analyser av urban godstransport har potensial til å bidra til kunnskapsbasert byplanlegging og beslutningstaking, som igjen kan redusere de negative effektene for og av godstransport i by. Et felles og tallfestet beslutningsgrunnlag blir også pekt på som bidrag til bedre samarbeid blant bylogistikkaktørene som følge av økt forståelse av hverandres situasjon og fokus på godstransporten. Dette kan bidra til å forbedre forutsigbarheten og effektiviteten for transportørene. Hovednytten transportørene ser for seg selv ved å bidra med data til et analyseverktøy er derfor å kunne bidra til et robust datagrunnlag, som øker deres konkurranseevne. Hvor stor verdi de ser i et analyseverktøy for egen planlegging av transporten varierer, og resultatene tyder på at verdien avhenger av hvor fleksibel planleggingen og transporten til transportørene er.

Om analysene vil bidra til disse gevinstene, avhenger imidlertid av formålet og egenskapene ved et analyseverktøy. Ifølge funnene fra denne studien, bør analyseverktøyet kunne gi et felles beslutningsgrunnlag, muliggjøre identifisering og formidling av potensielle gevinster/økonomiske gevinster for private aktører for å kunne stimulere til innovasjon og bidra til ny kunnskap om godstransporten for å gi nytte til verdikjeden. Formålet, ønskede resultater og tilgjengelig data vil påvirke egenskapene til modellen. Studien peker på at faktorer som må forbedres i et analyseverktøy på byskala omhandler: romlig og tidsmessig oppløsning; muligheten til å modellere en heterogen kjøretøysflåte og gjenspeile heterogeniteten i urban godstransport, ta høyde for kapasitet på veglenker og interagere med andre verktøy. Dybdeforståelse av hva et analyseverktøy skal ha som formål blir derfor viktig for å utvikle et hensiktsmessig verktøy.

Dybdeforståelse av formålet til et analyseverktøy, og hvordan det skal gi gevinst til transportørene, viser studien at er en av forutsetningene transportørene har for å dele data. Videre må det å hente ut og dele dataen kreve lite ressurser fra både planleggerne og transportørene sin side, og datasikkerhet og anonymitet må sikres for å overholde markedshensyn. Databruken blant transportørene og dataanalysen peker på potensial for automatisk datauttrekk på postnummernivå eller adressenivå. Adressene i de analyserte datasettene tyder på at adressene i dag ikke er standardisert, siden de fleste av transportørene planlegger på postnummernivå. Kjennskap til planleggingen av transporten til transportørene er derfor riktig med tanke på å forberede datauttrekk fra dem.

Gjennom studien ble utdrag fra leveransedata til transportørene undersøkt, og resultatet viser at det kan gi diverse informasjon om urban godstransport. I seg selv, kan leveransedataen fortelle om leveransemønsteret over dagen, attraksjon av leveranser til ulike steder og omfanget av leveransene. Dette kan hentes ut på adresse- eller postnummerdetaljeringsnivå avhengig av mengde manuelt arbeid som brukes på å standardisere adresser i eksisterende datasett, avhengig av hva som er hensiktsmessig. Det er imidlertid mye nyttig data til analyser og bylogistikkindikatorer som leveransedataen ikke kan gi. Dataanalysen viser derfor at kombinasjon av ulike datakilder vil være nødvendig. Leveransedataen er funnet til å gi mest informasjon om prestasjon, størrelse og omfang og utslipp fra godstransporten, men data på rutevalg, kjøretøysflåten og koblingen mellom sendinger og turer må samles inn for at leveransedataen skal kunne bidra til å tallfeste informasjonen.

Studien har derfor vist at det kan forventes fordeler for transportørene ved å dele data for analyser av godstransport i by, som kan være et insentiv for å få til mer datadeling i fremtiden. Om disse fordelene blir realisert eller ikke, avhenger imidlertid av hvordan analyseverktøyet utvikles. Denne må utvikles med formål om å redusere eksisterende utfordringer i byområdet og gi gjensidige fordeler til de involverte.

Contents

List Of Figures

List of Tables

1 Introduction

1.1 Motivation for the task

When I decided to write about city logistics in my master's thesis, specifically urban freight transport, and started reading literature within the field, the limitation repeated in most articles and studies was the lack of urban freight data. A lot of this data is being collected by the carriers, but is not widely accessible due to among other competitive reasons. I wanted to contribute by dealing with this problem "at the root", and use this opportunity to research what possibilities access to this data could give planners and researchers in city logistics, what it would take for the carriers to share this data, as well as to start researching whether it is possible to develop a method of data handling that is acceptable for them. Through this study, I hope to contribute insights into how city logistics can be better executed and solved more sustainably in the future. City logistics is often researched through case studies. However, I wanted to take a more general approach, and identify factors that can be applicable for different cases and future development of analysis tools for urban freight transport.

1.2 Background

Growth in urban freight transport
More than half of the world's population lived in urban areas in 2018, and in developed/industrial countries this percentage was higher than 81. By 2050, 68 per cent of the global population is projected to be urban, and nearly 88 per cent of the population in high-income countries (United Nations, 2019). Urban space is limited, and the urbanization puts increased pressure on the land, increasing the battle for space.

Simultaneously, the population is growing. All counties (fylker) in Norway have had population growth from 2008-2018, but there is a clear and persistent tendency that the largest population growth is in the larger towns and cities and in the most central parts of Norway (Kommunal- og moderniseringsdepartementet, 2018).

Freight is a derived demand, following the demand for goods/waste being moved to a location where they are more valuable (Ogden, 1992). An example of this, is how a product ordered by a consumer is more valuable in their home than the factory/storage.

A larger population leading to more production and consumption of goods and more economic activity taking place in the cities (urbanization), generates more freight demand in urban areas (Langeland et al., 2021), and thus more urban freight transport. For example, Oslo expects 30 per cent population growth and 50 per cent growth in freight transport by 2030 (Bjørgen, 2020). The projected average yearly growth in freight transport in Norway is 1.5 per cent until 2050, meaning that the total freight volume will have increased with close to 70 per cent from 2015 to 2050 (Meld. St. 33 (2016 –2017)).

Negative impacts of urban freight transport
As with any road transport, urban freight transport has negative impacts. Some of the negative impacts of urban freight transport include (Ogden (1992); Lepori et al. (2010); MDS Transmodal (2012)):

- Safety effects such as traffic accidents and incidents involving hazardous goods, especially conflicts between urban freight vehicles and pedestrians from reduced sight distances.
- Environmental effects such as noise, vibration and air pollution, local and global emissions.
- Demand for energy/fuel consumption.
- Land use impact by vehicles occupying road space including for unloading/loading.
- Low economic efficiency in urban distribution, specifically cost of logistic operations for producers, wholesalers, retailers, customers.
- Contributing to road congestion and low transport effectiveness.

All European cities face pollution, congestion and a range of problems related to the road use in urban areas (Patier and Routhier, 2008). Freight vehicles typically represent 8-15% of total traffic flow in urban areas (MDS Transmodal, 2012). This illustrates that the challenges the cities face from urban freight transport are common among different cities/countries, and that the decision makers have to implement measures to improve quality of life for their inhabitants whilst minimizing the negative impacts of road transport, including urban freight transport.

Challenges for the urban freight transport

The operation of freight transport in urban areas, is not without obstacles for the carriers. There is a high number of limitations for the distribution, such as traffic regulations, and fragmentation of freight flows decrease the transport effectiveness (Iwan (2014); Kijewska et al. (2016); Bjørgen (2020)). Challenges for the urban freight sector are also related to finding a place to park, and to the "last mile" before reaching the recipient. Often, lack of adequate infrastructure for the city logistics operations lead to inappropriate aids needed for this "last mile", as well as conflicts about limited space, leading to a challenging work environment (Presttun, 2019). The standard for delivery states that the distance from the vehicle parking to the recipient should be maximum 50 meters, and that the maximum force that the driver can apply to move the goods must not exceed 200 Newton, related to inclines (LUKS et al., 2014). A study done by Asplan Viak showed that drivers in urban areas walk 20 000-30 000 steps per day (Presttun, 2019), indicating how poorly planned solutions for delivering the freight have a large impact on the drivers, as well as economically, as this walking is time consuming and not efficient if the distances are long. If conflicts occur as a result of e.g. ad-hock solutions because of poor infrastructure conditions, the driver is the one left with tackling the problems. Challenges for urban freight distribution in Trondheim today includes too few and too small loading zones, not enough common places to receive freight, waiting, queues and extra rounds looking or waiting for loading/unloading space, too many vehicles not fully utilized, conflict with other modes of transport such as bikes, lack of focus on city logistics in the planning and inadequate systems for common distribution (Basberg, 2019).

Increased attention is paid to urban freight transport

In spite of the negative consequences from urban freight transport, and the challenges they experience, little attention has been paid to issues regarding urban freight, and logistical needs have often been neglected in urban planning and management (Patier and Routhier (2008); Debauche (2008); European Commission (2013)). This is also the case in Norway (Fossheim et al., 2017). Issues within urban freight have been regarded as a private sector issue, and not one for public authorities, and where regulation have been put in place decisions have been made at national or international, rather than on urban scale (Patier and Routhier, 2008). When the considerations are taken at urban scale, they can be more adapted to the local needs, and include the relevant stakeholders to a higher degree. The lack of coordination between stakeholders and exchange of data is also pointed out as a reason for the little attention paid to urban freight issues (Fossheim et al., 2017). The neglection of urban freight transport, despite being "absolutely essential to modern urban civilisation" was pointed out already in 1992 by Ogden (1992, p. 49).

However, the focus on sustainability is increasing, including how city logistics contributes to negative impacts, and potential for reducing these. As a result, the need for sustainable urban freight is getting more attention, with significantly more research activity, freight-specific conferences and seminars happening and papers published, reflected by more interest from policy makers, at local levels to transnational (Browne and Goodchild (2013); Neghabadi et al. (2019); Patier and Routhier (2008)). This has also led to private sector initiatives, as they realize the need to address these issues (Browne and Goodchild, 2013). The acknowledgement of the importance of sustainable city logistics is demonstrated by the European Commission in 2011 setting the goal to achieve carbon neutral city logistics in major urban centres by 2030 (European Commission, 2013).

Measures can have unintentional effects

Cities all over the world are setting ambitious goals, related to all dimensions of sustainability. In Norway, a zero-growth target has been defined for the nine largest city regions, which states that all growth in private transport should be handled by public transport, cycling or walking, as opposed to using a private car. To reach this goal, investments in public transport, biking and walking facilities are combined with restrictive measures

targeted at passenger transport by car, such as car-free zones and reduced parking areas (Meld. St. 33 (2016 –2017)). On the one hand, stopping the growth in passenger transport by car in the cities can improve the situation for the freight transport, leading to more efficient distribution. These measures do, however, affect driving patterns of freight transport as well, which can lead to unintentional negative impacts. In order to complete their distribution, drivers of freight transport can primarily change the route of the trip to adapt to the traffic situations, as the time of deliveries is less flexible. Adapting the route to avoid restrictions, might lead to the freight transport drivers having to drive longer distances, or queues. Measures meant to reduce the negative externalities of transport, can in this way threaten the competitiveness by reducing the efficiency of the freight transport and increase the transport costs, as well as lead to more miles driven, and more transport related emissions.

Furthermore, freight transport is not included in the zero-growth goal. It is omitted in order to facilitate services and ensuring competitive conditions for the freight transport (Meld. St. 33 (2016 –2017)). This can, however, be questioned given that urban freight transport accounts for significant emissions and other negative impacts, and considering the expected persistent growth in urban freight transport. Implementation of measures such as zero-emission/low-emission zones and limitations on freight vehicle sizes are being discussed in the largest cities. To avoid negative consequences such as those described, this increases the need for more sustainable approaches to city logistics.

Approaches to more sustainable city logistics

There are several approaches contributing to more sustainable city logistics being researched. Among these are urban consolidation centres, off hours deliveries, alternative vehicles (electric vehicles, cargo bikes, boats, drones, public transport), delivery lockers, focus on safety and education that leads to better planning and design (Pitera, 2020).

In order to implement and sustain these innovative approaches, planning for and enabling efficient and sustainable urban freight transport through effective city logistics plays a key role. Planning for efficient urban freight transport can take different forms including increased accessibility/traffic flow, reduced traffic and more effective land use (Karlsson and Bjørgen, 2019). The planning process, also plays a role: "Improvements to the Norwegian planning process, namely earlier integration of freight considerations, are required to ensure sustainable freight systems in the urban environment" (Pitera et al., 2017, p. 1). To be able to do this, more/better data and modelling is needed (Pitera, 2020). Data and statistics are needed to support decisions in planning, management and assessment of urban transport policies (Steenberghen et al., 2013). Presttun et al. (2018) have reviewed the current situation and challenges in city logistics, and show that "data for city logistics is deficient and divergent. There is a lack of an overall numerical basis (overordnet tallgrunnlag) that explains freight and service transports in cities in a good way" (Presttun et al., 2018, p. 6).

Barriers for collecting and sharing urban freight transport data

There are, however, several barriers for collecting and sharing urban freight transport data. The diversity of products and business models contribute to making the challenges complex (Browne and Goodchild, 2013). Due to the many stakeholders involved, there is a lack of ownership of the problem and thus lack of coordination, lack of data, lack of focus and strategy and conflicts of interests (Karlsson and Bjørgen, 2019). The cost of data collection and modelling is high, poor data collection on local level leads to lack of knowledge, and the link between urban deliveries and whole logistics chain is not represented well in current analytical tools (Patier and Routhier, 2008). Furthermore, the numerous activities requires data collection from many economic agents, the shippers and transport actors are reluctant to share information regarding their operations, there is lack of understanding on what data is needed by the local authorities and cost of collecting and updating the data is high (Campagna et al., 2007). This lack of data makes it difficult to take informed decisions (Meyer and Meyer, 2013).

Opportunities from urban freight data

Urban freight data enables investigation of specific projects and initiatives, monitoring and measuring of performance, meeting requirements from directives, producing national estimates, modelling and forecasting freight transport, controls of safety and licensing, investigations of crimes and commercial monitoring (Browne

and Allen, 2006*a*). Data on freight movements also makes the authorities able to understand the impact measures could have on all stakeholders, and to assess whether the measures have had an impact by evaluating the project (MDS Transmodal, 2012). Specifying the information needs within urban freight transport, would contribute to taking control over the area and developing it more sustainably (Stanisław et al., 2015). In addition, data can demonstrate the scale and significance of the problems and give politicians ground for "unpopular" measures mitigating the negative effects of the problems (Steenberghen et al., 2013). Lack of data makes it difficult for planners to consider how the implications of projects/initiatives for other road users might lead to unintended effects for the freight distribution (Patier and Routhier, 2008). The unavailable or low quality data and lack of effective data collection methods is a barrier to understanding stakeholder behaviour and implementing suitable and efficient measures (Campagna et al., 2007). Access to data about the freight transport network on the other hand, enables learning from it and "deducing targeted regulation measures for the network" (Otte and Meisen, 2020, p. 1). Furthermore, learning from data and their interrelation enables the possibility to "derive benefits for the overall system" (Otte and Meisen, 2020, p. 2).

Urban freight data enables investigation of specific projects and initiatives, monitoring and measuring of performance, meeting requirements from directives, producing national estimates, modelling and forecasting freight transport, controls of safety and licensing, investigations of crimes and commercial monitoring (Browne and Allen, 2006*a*). Data on freight movements also makes the authorities able to understand the impact measures could have on all stakeholders, and to assess whether the measures have had an impact by evaluating the project (MDS Transmodal, 2012). Specifying the information needs within urban freight transport, would contribute to taking control over the area and developing it more sustainably (Stanisław et al., 2015). In addition, data can demonstrate the scale and significance of the problems and give politicians ground for "unpopular" measures mitigating the negative effects of the problems (Steenberghen et al., 2013). Lack of this information makes taking decisions on issues connected to freight transport difficult, including road space allocation, congestion, its role in energy consumption and air quality, safety and security issues, modal shift and land use planning (Patier and Routhier, 2008). Lack of data makes it difficult for planners to consider how the implications of projects/initiatives for other road users might lead to unintended effects for the freight distribution. The unavailable or low quality data and lack of effective data collection methods is a barrier to understanding stakeholder behaviour and implementing suitable and efficient measures (Campagna et al., 2007). Access to data about the freight transport network on the other hand, enables learning and "deducing targeted regulation measures for the network" (Otte and Meisen, 2020, p. 1). Furthermore, learning from data and their interrelation enables the opportunity to "derive benefits for the overall system" (Otte and Meisen, 2020, p. 2).

Information on commodity flows and transport is an important part of urban freight transport. Lack of information on cargo streams and their direction, makes it difficult to limit their negative impact on the environment and society (Kijewska et al., 2016). Lack of data and understanding of freight flows is pointed out as one of the main obstacles for efficient and sustainable urban freight transport (Campagna et al., 2007). Lack of information on goods management also contributes to lack of knowledge on the commodity flows. Without being able to explain these flows, prediction based on current models is not efficient (Sonntag and Meimbresse, 2008).

Stakeholder collaboration and technology bring potential

Currently, logistics decisions are typically taken by the supply chain, considered only on the basis of commercial and operational factors (MDS Transmodal, 2012). However, in order to obtain increased efficiency in city logistics, the stakeholders' involvement, engagement and willingness is crucial (Neghabadi et al., 2019). Trust, commitment and a clear understanding of stakeholder behaviour is necessary to address adequate and efficient city logistics measures due to the complex stakeholder relations with conflicting goals and the confidentiality of information (Lepori et al. (2010); Neghabadi et al. (2019)).

Technological developments contribute to growth in available data on transport (Hovi et al., 2016). Data resources are growing, and data collection technologies such as GPS-tracking are becoming available. Being able to extract knowledge from these, and ensuring efficient information flow, is necessary for efficient management of urban freight transport (Stanisław et al., 2015). Data on commodity flows and the urban freight transport

is to an increasing degree being collected by the transport operators, sometimes automatically. Getting access to this data, could contribute to breaking down the barriers of the current unavailable or low quality data and lack of effective data collection methods for efficient and sustainable city logistics. Mjøsund et al. (2020) point out how collaboration between the public and private sector is needed in order to have better data for the urban freight transport models of the future.

Utilizing data that the freight actors are collecting electronically

Several data sources are used for urban freight data today, such as traffic counts and tracking data, collected by the public sector, with potential to be improved. Another source of urban freight data that is not in widespread use today, is the data that the freight actors are collecting themselves. Using methods for automated extraction of data from the databases of the firms in urban freight transport could simplify the data collection and make it more efficient, enabling more detailed data and reduce the number of links in the data collection, leading to better quality and quantity of the data (Hovi et al., 2016). Resulting from the companies needing data themselves and demand from the customers, more and more companies are likely to implement systems that support collection and reporting of the relevant data the next few years. Furthermore, this data will likely be of sufficient quantity and quality and reported automatically, without extra cost or resources required. This enables more data to be collected with higher frequency than today, without providing more work for the companies. The data could be analyzed with methods that automatically identify and correct faulty reports, double reports and deficient reports (Natvig et al., 2016). For example, Hovi et al. (2019) have through the LIMCO-project (Logistics, Environment and Costs), identified a reduction of fuel emission of 7-8% by exploiting data from trucks, specifically a solution that was used to give access to driving behaviour and gave weekly reports to the driver on this behaviour.

The effects of electronic reporting of freight data is according to Natvig et al. (2016, p. 68):

"Simplified data reporting - using automatic data capture and automatic reporting; simplified processing of data - by the data being in the same format; better quality of data - i.e. correct data and more detailed data; new possibilities for the use of data - among other things in detailed analyses and in transport models for urban areas; new knowledge as a result of new data - including knowledge about transport chains and their use of terminals, identification of bottlenecks in current infrastructure, knowledge of the potential of improved effectiveness of the transport, and knowledge to the industry".

Otte and Meisen (2020, p. 1) point out how "supported by an ongoing digital transformation and various promising developments as well as supportive political initiatives in the field of urban freight transport, public authorities are likely to gain access to these data in the future", and that cities therefore "should prepare themselves to be able to handle the data as soon as they can be accessed". Otte, Solvay and Meisen (2020, p. 8) point out how "instead of isolated data-exchanges, centralized high-quality data flows from different actors (e.g., several freight carriers operating inside the city) are of interest to form a fundament for a sustainable urban development in the context of urban freight transport".

Incentives for the freight actors

Given that lack of correct freight data might result in the needs of the freight transport not being taken care of, , the incentive for private actors contributing data is that this would enable the government to prioritize projects improving the conditions for their services (Natvig et al., 2016). Furthermore, contributing open source data to enable more sustainable solutions can give the companies a greener profile. More and better data can provide more precise formulations of the needs of the urban freight transport sector to public authorities. Developments in the field and political objectives are contributing to increased willingness to share data by targeted incentives (Otte and Meisen, 2020). In their abstract, Otte, Solvay and Meisen (2020) point out how establishing a data-based cooperation between freight carrier companies "promises benefits for both the companies and the overall transportation network", as a mean for meeting the trend of increased frequency of shipments in urban spaces. However, they also point out how lack of "quantification and communication of the potential benefits" contributes to explaining why data sharing from private companies is not common today, and therefore that "recognizing these benefits would serve as a strong incentive and leverage the involved actors to cooperate." (Otte, Solvay and Meisen, 2020, p. 8). Identifying the benefits will therefore be important work

in order to incentivize the data sharing.

1.3 Research objectives

Rapid growth in urban freight transport is expected. Trends as urbanization, increased e-commerce and home deliveries contribute to increased battle for space in the cities and changing the freight transport and commodity flows. Simultaneously, the growth in passenger transport will presumably be eliminated through targeted restrictions and measures in line with the zero-growth goal. Urban freight transport will therefore constitute a larger part of the traffic in cities in the future than today, and the effect of these measures on the freight transport proportionally greater.

There are several innovations that can lead to more efficient city logistics. If the aim is to implement innovative solutions in a good way, the ability to predict and calculate and estimate future transport volumes and impacts from the measures would be useful.

Knowledge on the urban freight transport - the quantity and where it goes, the challenges for the urban freight carriers today, and the effect of restrictions on passenger transport by car on them, is important in order to avoid negative unintended impacts of measures targeting passenger transport on urban freight transport, as well as for implementing solutions for more sustainable city logistics.

In order to do that, reliable and high-quality data on the freight transport on urban scale is needed. Today, the public lack access to detailed data providing knowledge about freight transport in Norwegian cities. One of the reasons for this, is the reluctance among carriers and other actors in the urban freight market to share data for market reasons. However, new technology means that freight transport data is increasingly being collected and enables efficient data sharing.

This has led to the following main research question for this master's thesis:
How can collection and analysis of urban freight data from carriers contribute to more sustainable city logistics?

This is followed up by the sub-questions:

- (1) What are the potential benefits of urban freight transport analysis for more sustainable city logistics?
- (2) What is required to improve current freight transport analysis?
- (3) How can and should data from the carriers be obtained in order to enable these analyses?
- (4) What opportunities does carrier delivery data provide for these analyses?

The first and second questions were examined through interviews with planners, researchers and policy makers involved in city logistics. The participants were interviewed about what analyses they do today, what information/data these are based on, as well as what opportunities/insight an analysis tool for urban freight transport can provide, and what data would be most valuable for this. The findings were used to investigate the potential that collecting selected data on urban freight transport for a common tool would have for planning for more efficient urban logistics; and what properties such a tool should have. The interviews have provided insight into what data is required the most, and what may not be necessary to collect. This gives an indication of how best to start systematic work with the collection and use of freight transport data on an urban scale.

The third question was examined through interviews with carriers in various sectors of urban freight transport, as well as with the planners/researchers/policy makers. The carriers were interviewed about the willingness to share data, including what data they are willing to share, and under what conditions. This helped to identify strategies for obtaining valuable data without compromising their interests. The characteristics of required data for the planners/researchers/policy makers will provide guidelines on how the data should be collected in order to enable them to improve planning/regulation.

The fourth question was examined through analysis of example delivery data sets from the carriers. The findings were used to research how these data sets can contribute to close the knowledge gap and enable analyses, as

well as potential methods for extracting data from the data sets to a tool.

Analysis tools is used in this study for describing a tool that meets the analytical needs of planning towards more sustainable urban freight transport. Access to analysis tools is seen as a subset of analytics. More sustainable is defined as more efficient in terms of operational cost, i.e. an economic aspect, more accessible for all in terms of equity, i.e. a social aspect, and with less carbon footprint, pollution, being more environmentally and climate friendly, i.e. an environmental aspect.

1.4 Scope and limitations of the study

City logistics and urban freight transport is complex, connected with all parts of society and all parts of the world. There are therefore a wide range of interesting perspectives and approaches to study this, and a lot could be included in a study. However, "for a project to result in anything, one have to specify the research questions (avgrense problemstillingen)", as there often are "many issues within a topic one wants to say something about" (Holme and Solvang, 1996, p. 38).

Several delimitations have therefore been made. Related to the scope of participants and geographical focus:

- The study is based on the biggest cities in Norway, and the data collected and transport operators contacted are from Trondheim.
- In cities, there are commodity flows to retail, to institutions, hospitals, municipality, to construction sites and to other infrastructure. However, the sample does not cover the whole urban freight transport picture, due to high number of involved parties, and the limited time of this study.
- City logistics and urban freight transport is not isolated. The freight is transported into the region (Trøndelag) through the distribution centres (railway station and docs, which in Trondheim are in the city centre), before being distributed, and freight from the producers transported to these distribution centres out of the region. These commodity flows coming into and going out from the distribution centres in Trondheim affect the road network on the main roads, and the access roads to the main roads. This perspective is however not the main focus of this study.

Regarding the purpose of the study:

- There are different types of analysis tools for transport, such as transport models. The intention of this study is not to design such a tool, but rather give suggestions on what the functionality of such a tool for urban freight transport should be. Who should have access etc., is outside the scope. The findings on how stakeholders in city logistics see potential in a tool like this, may be useful for those who want to develop such a tool in the future.

Regarding the data for the analysis of example freight delivery data sets:

- The example data sets collected from the carriers for the analysis do not aim to be representative. The data is limited in time and space, concentrated to the Trondheim region.

1.5 The structure of the report

The literature is presented state of the art in chapter 2 and the method in presented in chapter 3. In chapter 4 the results will be discussed in light of the State of the art. Based on what has been presented, the study will wrap up in the conclusion in chapter 5, including further outlook/recommendations for further work is presented.

2 State Of The Art

The State of The Art is identified through a literature review on city logistics and urban freight transport, specifically with regards to urban freight data, in order to identify the gaps.

2.1 Approach

The literature search was started in Google Scholar and Oria. Further sources were identified through "snowballing", i.e. following a source used in another article. If not otherwise stated, the primary source has been consulted in order both to give credit to the original author and avoid misinterpretations from rewritings. Using secondary sources can "give a skewed reproduction of the primary source that will be "inherited" if one only refer to the secondary source" (Holme and Solvang, 1996, p. 320). Norwegian as well as English literature was used. Quotes from Norwegian literature was translated to English, at times including parts of the original wording for clarity. The search started wide, capturing general information about the topic of urban logistics as a whole, and was narrowed down gradually after closing in on the subject of study, towards the research questions and more specific literature on urban freight data and data collection, as illustrated in figure 2.1.

Figure 2.1: The literature search from more general to more specific

.

The literature was primarily scientific papers in peer-reviewed journals, conference papers and book chapters. The books were read to obtain wider knowledge and understanding, whereas the journal and conference papers provided research results and specific knowledge closer to the research questions of this study. Previous master theses within the field were also used. Reports from TØI make up a large share of the resources. They have conducted a lot of relevant research the last years, which gives good information on the Norwegian situation. In addition, more recent information presented in the media have been used. This is to include up to date examples, as there is a lot of development within the field.

There are many different terms used within the field at times with different or overlapping meanings. The definitions used in this report is presented in section 2.2.

2.2 Defining city logistics and urban freight transport

City logistics

Neghabadi et al. (2019) have executed a systematic literature review on city logistics, and state that "regarding the definition and perimeters, city logistics not only comprises urban freight transportation and distribution, but also encompasses the goods handling and storage, waste and return management and home delivery services" (Neghabadi et al., 2019, p. 876). This study will base the relationship between urban freight transport and city logistics on Neghabadi et al. (2019), and urban freight transport thus seen as a subset of city logistics. This is in accordance with Pitera (2020), who defines the goal of city logistics to regulate freight distribution activities to minimize the negative impacts on the urban area. However, as opposed to Neghabadi et al. (2019), home deliveries and renovation are included in urban freight transport, in line with other sources, and as illustrated in

the next paragraph. The fact that city logistics include more than only transport, is essential to reach the goal of environmentally friendly urban freight transport (Presttun et al., 2018).

City logistics in this study therefore include the aspects illustrated in figure 2.2 based on Neghabadi et al. (2019).

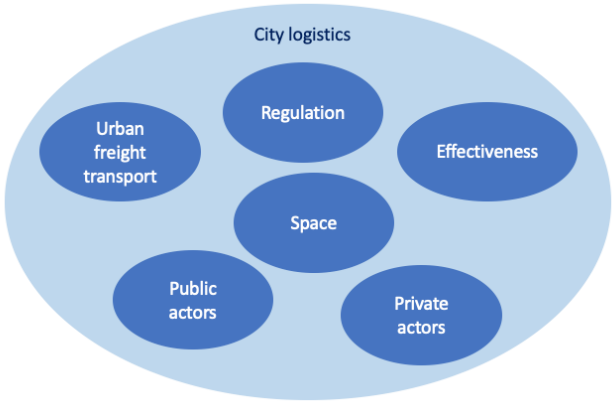

Figure 2.2: The components of city logistics based on the literature review.

City logistics is the last leg of supply chain, i.e. a subset of the supply chain, considering the freight transport only in urban areas (Neghabadi et al., 2019).

Urban freight transport

Urban freight transport is "the movement of freight vehicles whose primary purpose is to carry goods (as opposed to people) into, out of and within urban areas" (MDS Transmodal, 2012, p. 2). Several terms are used to describe the movement of goods and services, and there is no common definition of the terms (MDS Transmodal, 2012). "Urban freight transport" and "urban freight movements", "urban goods transport" and "urban goods movements", as well as "city logistics" and "urban logistics" and "urban freight/goods distribution" is used for describing overlapping concepts. In this study:

- Freight is used over goods, as two synonyms (i.e. urban freight transport, and not urban goods transport)
- Transport is used over movements (i.e. urban freight transport, and not urban freight movements)
- As described, urban freight transport is a subset of city logistics.

In line with Otte and Meisen (2020, p. 8), the perspective of this study is that "urban freight transport contains the entirety of freight movement inside a city considering as well the involved actors (e.g., organizations), applied technologies, processes and single entities inside the urban transport network".

Urban freight includes several sectors. There is some variation in the literature in terms of what sectors are included, but the most fragmented and comprehensive list based on MDS Transmodal (2012), Neghabadi et al. (2019), Fossheim et al. (2017) and Jensen (2019) is that freight traffic is generated from: construction, retail (including e-commerce), renovation, hotel, restaurant and catering, delivery services, express courier and post, as well as mobile services. Freight vehicles include heavy goods vehicles and light goods vehicles, where the heavy freight vehicles are over 3.5 tonnes gross laden weights (MDS Transmodal, 2012).

Stakeholders and their objectives

A variety of stakeholders are involved in urban freight transport and city logistics. The stakeholders are categorized in many ways in the literature. Lepori et al. (2010) have grouped the stakeholders in urban freight transport according to their predominant role either:

- Representing demand.

- Planning and executing urban freight transport services.
- Hardware/software providers.

Neghabadi et al. (2019) have grouped the stakeholders in city logistics as either public stakeholders or private stakeholders. MDS Transmodal (2012) have grouped them based on their involvement in the freight transport:

- Within the area not directly involved in freight transport.
- Directly involved, i.e. actors in the supply chain, where their role/responsibility is either:
  - Demanding goods.
  - Supplying goods.
  - Transporting goods.

The categorizations illustrate the difference/variety/opposing nature of the involved stakeholders:

- Some stakeholders are directly involved, while some are not. As a result, there is a difference in the economic interest and power, as well as their access to data on the transport, willingness to share this data and in protection of own interests.
- Some stakeholders are public, and some are private. These have different responsibilities, possibilities and budgets.
- Some stakeholders represent the demand, and some the supply. These roles create different data, purposes and challenges.

These have different, often conflicting, goals and objectives (Lepori et al. (2010); Iwan (2014); Neghabadi et al. (2019)). The difference in objectives, often leads to conflict of interests (Kijewska et al., 2016). The objectives found in the literature review can be illustrated in a multi-stakeholder conceptual diagram, as shown in figure 2.3 (framework inspired by Harrington et al. (2016)). This shows the inter-dependencies, common interests and trade-offs:

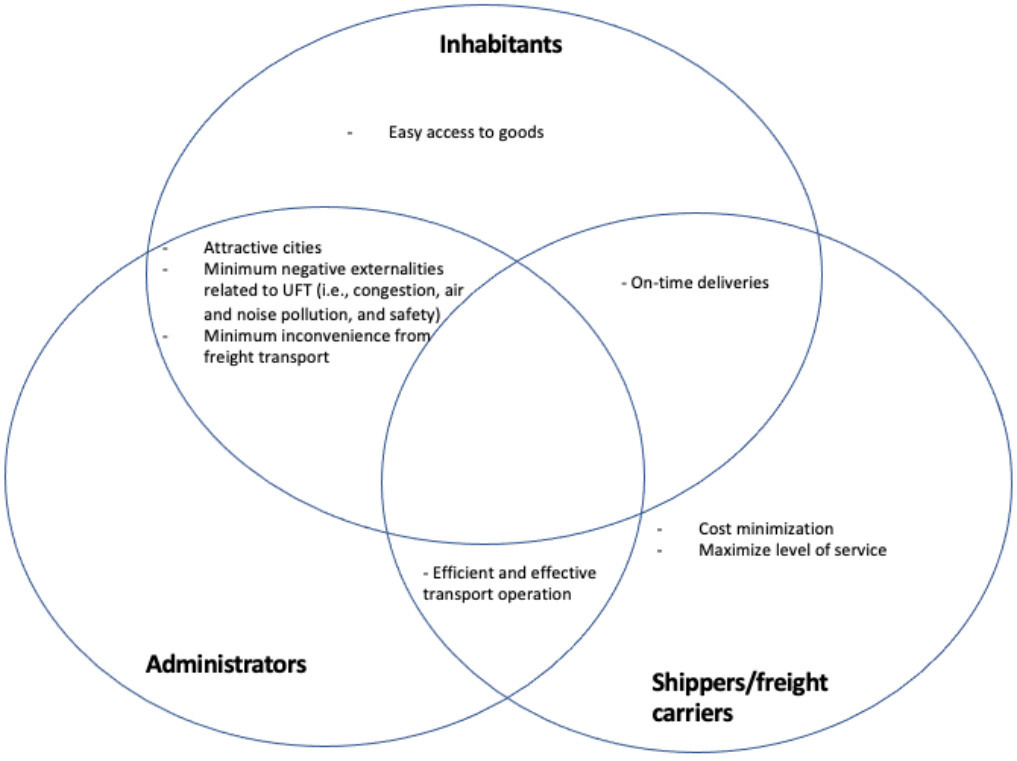

Figure 2.3: The objectives of the stakeholders involved in city logistics.

The figure illustrates how several of the goals are common. When the stakeholders' objectives are aligned, it indicates potential of collaboration between the stakeholders, through activities improving the situation for both/all actors. As an example, efficient and effective transport operation is a goal for both the administrators and shippers/freight carriers (transport operators). In order to have efficient city logistics, Taniguchi et al. (2001) have pointed out the need to recognize all stakeholders' different objectives and manners, as previously mentioned. This also shows that there is a range of goals that all stakeholders have, and how integrated solutions avoiding sub-optimization is useful.

2.3 Defining urban freight data needs, data availability, data gaps and data collection

Data **needs** in this study is defined as the data that is required in order to plan for or execute sustainable city logistics, including urban freight transport as a subset of city logistics.

Data **availability** is defined as whether the stakeholder in question has access to the data. Lack of available data can either be caused by the data being owned by someone else, the collected data not being of adequate quality/quantity, or because there are no sources collecting the data.

Data **gaps** is in this way defined as the required data which is not available. Then there is a data gap.

Data **collection** is the method in which the data is collected. This includes the sample size, method, documenting and reporting. A faulty data collection can lead to data gaps.

The data in focus is from the urban freight transport involved in city logistics, and is therefore named urban freight data, as short for urban freight transport data. When using the term data in the following, this means urban freight data (=urban freight transport data), unless otherwise stated.

2.4 Modeling urban freight transport

Urban freight is complex due to the interaction of many involved stakeholders with their own interests and perceptions of what issues are the most important. This makes analysis and modelling it difficult, thus making it difficult to achieve solutions for sustainable distribution (Ogden (1992); MDS Transmodal (2012)).

Several sources have pointed out the challenge of the long term nature of some strategies, when the focus of the policy makers often is on short term problems and solutions (Debauche, 2008). However, this might be changing, as there is increased focus among the policy makers on the importance of urban freight transport in order to achieve their goals. Modelling requires data collection, processing, model building, calibration and validation, and is currently too time consuming for decision makers focusing on short term problems and solutions (Debauche, 2008). Using forecasting techniques to account for economic growth, change in population, household size, income, car ownership etc. would be useful for urban freight modelling (Steenberghen et al., 2013). The forecasting ability, to forecast variables such as commodity flows or truck trip generation based on fundamental factors such as floor area, is mentioned also by Ogden (1992, p. 267). There have, however, not been many attempts to do these forecasts or develop long-term policy options (Debauche, 2008).

Ogden (1992, p. 264) presents characteristics of an ideal urban freight modelling framework. It should:

- Be behavioural - which means that it describes the relations between specific transport service demand and the key determinants of the demand.
- Be multi-modal - meaning that more than one truck mode, and several purposes/operations can be handled.
- Include both passenger and freight movements and their relation, most importantly where conflicts occur, in order to model the traffic flow.
- Show the feedback effects of changes in policy variables.

- Be dynamic - meaning that it shows the response in movement from one equilibrium position to another from policy variable changes.
- Have general applicability - meaning that it can be applied to urban areas with similar topological, demographic, economic and transport system characteristics.

A lot of urban freight and related data inputs are typically required for urban freight models. Developing and carrying out detailed urban freight modelling exercises is therefore not possible at present, due to insufficient data availability and quality, as well as lack of resources to develop the models (Browne and Allen, 2006*a*). When the urban freight data is available, it is often not compatible with required data on economy or land use in space or time (Patier and Routhier, 2008). Data also needs to be collected for the purpose of urban freight modelling or in a way that is compatible with it, so that the data can be used for statistical sampling and have spatial or temporal relevance (Browne and Goodchild, 2013). The locations of the origins, destinations and places of repacking of the freight should be included in order to map the commodity flows (Natvig et al., 2016), and a way to automate the process of joining with coordinates could be useful. Data is required both for input to the model, and for verifying and validating the model. Tracking data and data from traffic counts could be used for validation (Natvig et al., 2016).

This illustrates a need to coordinate the collection and processing of different data types, to collect and process it in a flexible way, and documenting the process, in order for it to be used in analyzes. The input data used for feeding and calibrating models have to be well described in order for the output to be useful, and to know the limitations of the models and thus its results (Routhier, 2008). In order to have sufficient data for urban freight modelling, Browne and Allen (2006*a*, p. 27) state that "major increases in resources to collect urban freight data are likely to be necessary".

Hansen et al. (2017) recommends developing freight transport models for the cities in Norway, initially for the Oslo-region. These models should be for smaller geographical areas than the whole Norway, because the models become heavy. However, the more dis-aggregated the models are, the larger is the uncertainty related to each number. These models should therefore be built on different data. Hansen et al. (2017) mention that the freight flow matrices in NGM do enable more detailed zonal divisions, but this division is not validated or implemented in the model. This indicates that there is potential, but that this detailed zonal level has not been demanded at a national scale. For models on smaller geographical areas, Hansen et al. (2017) mention that route choices with several senders and recipients on the same freight route and time differentiation could be included, enabling analysis of time differentiated measures and driving restrictions in zones in the city. Time differentiation is also pointed out as useful on urban scale by Mjøsund et al. (2020, p. 7), as it "enables modelling different costs and transport travel times at different times of the day, which can be relevant if the model is to be used for analyzes of capacity problems, rush fee etc."

2.5 Urban freight data needs

Indicators describing city logistics and urban freight transport is useful in order to ensure a development in line with the overall goals, and well established indicators a step towards analysis tools. Indicators also point to what data needs to be obtained (Eidhammer, 2021), and can be compared over time. The data needed to calculate indicators should be "easily available or possible to collect relatively easily, be well documented and with acceptable and known quality, and updated regularly with reliable procedures (Fossheim et al., 2010, p. 11).

Three studies presenting indicators are presented here, combined to a comprehensive list of urban freight indicators. Fossheim et al. (2010) have researched indicators for environmentally friendly logistics related to drivers, transport, environment, consequences and planning and politics, while Halatsis et al. (2016) have presented a set of urban freight city characteristics, which with their magnitude, define how efficient the urban freight transport is. Based on previous research and industrial initiatives, Halatsis et al. (2016) have identified characteristics in this literature and validated during a NOVELOG Training Seminar in Bologna in April 2016, and come up with a final list of urban freight transport characteristics. The last source is Patier and Routhier

(2008) which have, through the BESTUFS project, researched the best practice in data collection, modelling approaches and application fields for urban commercial transport models.

Table 2.1 show the total table of urban freight transport indicators. The sources for each indicator is included in appendix 6.1 It is seen that the indicators can be categorized as either representing the urban freight transport or the environment, with several sub-categorizations. Most of the indicators are on the urban freight transport. The indicators point to a range of data needs, and the large variety of indicators illustrate how thorough knowledge is needed.

Table 2.1: Indicators for urban freight transport based on Patier and Routhier (2008), Fossheim et al. (2010) and Halatsis et al. (2016).

UFT/CL	Loading/ unloading activities	Share of illegal on-street loading/unloading in total deliveries
		Number of loading/unloading in each activity [Number of deliveries and pick-ups per employee per time unit]
		Loading/unloading density in a zone [Number of deliveries and pick-ups per km2]
		Loading/unloading intensity per activity in a zone [Number of deliveries and pick-ups]
		Loading/unloading time in a zone, per vehicle, per activity [Number of hours of on street double parking for delivery or pick-up]
		Distance covered for loading/unloading in a zone, per vehicle, per activity [Number of kilometres covered for one delivery or pick-up]
	Perform-ance	Average journey speed during peak hours
		Average speed per round including stops to make deliveries [km/hour]
		Average speed per round excluding stops to make deliveries [km/hour]
		Transport efficiency [tonnes-kilometres/vehicle-kilometres]
		Rate of empty kilometres [% of vehicle-kilometres]
		Trip distribution by day and time of the day [time intervals]
		Share of deliveries/pickups made between 07:00-10:00 hrs
		Delays for freight transport (næringslivets transporter)
		Average payload per kilometre per tour, per activity, per type of vehicle [ton*km]
		Transport content [vehicle km/tonnes]
		Quantity of goods delivered/collected (average size of goods delivered/ collected per drop)
	Delivery conditions	Stop times for deliveries (average dwell time) [minutes per delivery]
	Size and extent	Freight transport performance in terms of tonnes-kilometres (transportarbeid)
		Freight transport performance in terms of vehicle-kilometres (trafikkarbeid).
		Total distance travelled on roads in urban area transporting goods by HGV, rigid lorries, and LGV
		Number of vehicles involved in deliveries and pick ups per hour per type per size [Number of vehicle /h]
		Average distance travelled per pick up/delivery [Km per pick up or delivery]
		Number of deliveries/ collections [average number per establishment per week]
		Journey length (average round trip length)
	Vehicles	Share of trips undertaken by ennvironmental-friendly means
		Distances covered by vehicle use
		Distances covered by vehicle use
		Share of delivery trips made by vehicles of less than 3.5 t gvw
Environ-ment	Energy use	Energy used by mode [GWh/year]
	Emissions	Total emissions (local emissions and GHG emissions) by mode [tonnes/year or tonnes/year/capita]
		Emissions (local and GHG) per tonnes-km and per vehicle-km [gram/km]
		Greenhouse gas and pollution according to the zone, the vehicle, the activity, the management (g Pollutant per km; g CO2 per km; litre of fuel per km)
	Land use	Average length of the first leg from platform to the delivery area
		Size of land used for freight facilities [m2/capita]

For **modelling the urban freight transport system**, information such as the total number of trips in the area, the origin and destination of these trips, the vehicle types and vehicle compositions, the decision criterion for routes is needed. Input data is needed to make the model, and other data is needed for verification and validation. The data collection and processing have to be well described.

Otte, Solvay and Meisen (2020) have researched a possible data foundation for the operative steering of the urban freight transport system, and their work presents potential data sources, data elements, as well as their interrelations and possible deducted key performance indicators for modelling urban freight transport. Otte, Solvay and Meisen (2020, p. 6) have identified three data sources:

- Data measured by the city, such as sensors counting amount of traffic.
- Data generated by other actors, such as schedules from public transport companies or number of shipments and distributions to different types of delivery vehicles from freight carriers.
- Data from other sources which have an effect on the urban freight transport system, such as events or weather forecasts.

Furthermore, Otte, Solvay and Meisen (2020, p. 6) have identified the three key elements of the urban freight transport being shipments, vehicles and the transportation network itself, where the shipments are assigned to the vehicles, and the vehicles subsequently deployed into the network. In this way, the authors state that there is a "direct relation between these three elements and the associated data". Data on these three elements is therefore needed. The data source for data on shipments, is identified as "generated from other actors", specifically shippers and freight carriers, and the data source for data on vehicles as the freight carriers. Data on the transportation network comes mainly from "other sources", such as Open Street Maps, while freight carriers are identified as the source for specifically the hub position, hub capacity and the hub load factor. Only the data generated by other actors, specifically within urban freight transportation, is in focus in this study.

This data can be used to deduce key performance indicators on different perspectives, such as per vehicle, per fleet or per city segment, spatially or temporally, (Otte, Gannouni and Meisen (2020); Otte, Solvay and Meisen (2020)), enabling to draw conclusions on the capacity and performance of the transportation network. Based on these conclusions and the knowledge of current status and development of the transportation network, data-based solutions can be made to improve "the productivity and efficiency of the overall urban transportation network" (Otte, Gannouni and Meisen, 2020, p. 3).

The data on urban freight vehicles, giving a picture of the freight vehicle fleet composition, is important. The vehicles range from 5.7m to 25.5m, which affects the impacts on local and global emissions and pollution, land use in queues and perceived and actual safety and uncertainty in the traffic in cities (Presttun et al., 2018).

Generic data needs

It would seem efficient to have a generic set of data needs and analyzing techniques to apply in urban areas. However, this is a challenge, as the data needs "will vary with the issue concerned, the planning and policy framework within which the issue arises, usual practice in the agency concerning such things as data collection and modelling, and the availability of previous data" (Ogden, 1992, p. 305). Regarding what data is needed for urban freight data collection, Ogden (1992, p. 308) further states that: "Whether a given item or source is in fact relevant in any specific instance would need to be assessed on a case by case basis". Patier and Routhier (2008) also point out how the data required depends on the specific situation, including the planning and policy framework, and what data and data collection methods are existing and available. It is therefore important to know the limitations of generic frameworks, while simultaneously to exploit what is actually general.

However, even though completely general application of data needs is not possible, or wanted, developing relationships between urban area characteristics and data needs, and indicative guidelines describing how they should be applied, with practical examples could streamline the data collection. In this way certain data can be teamed up with certain issues they will help solve.

2.6 Available data

The available data presented is focused on road freight transport, since urban freight is primarily distributed on road networks within the cities of Norway.

Traffic data
Traffic data is related to vehicle movements (Hovi et al., 2016).

Traffic counts based on the lengths of the vehicles are often used as proxy for the goods transport. In Norway, the National road authorities classify long vehicles as 5.6 meter or longer, which includes vehicles such as trucks, long vans, buses, tractors and vehicles with trailers. In line with the findings from Browne and Allen (2006*a*), Browne and Goodchild (2013) point out an existing weakness in the understanding of urban freight being the lack of data collected on and models addressing light vehicles (below 3.5 tons in the European Union and 14,000 pounds in the United States). Light vehicles contribute to a large part of the urban freight transport flows being responsible for most service trips and many deliveries and collections; as high as 50% in France (Browne and Goodchild, 2013). In Oslo, 11% of the passings across the toll ring is estimated to be by urban freight vans on an average weekday. In Bergen and Trondheim, the equivalent percentages are 15% and 5%, respectively (Denstadli et al., 2014). The traffic counts being based on length means that many vans, that are less than 5.6 meters, are counted as passenger vehicles. In this way, their contribution to the urban freight transport is lost. In addition, this classification based on length, implies that buses can be confused with freight vehicles over 5.6 meters in automatic counts. On the main roads between cities, this categorization catches the freight pattern well, as there is mostly long vans and trucks involved in the road freight, and not many buses. In urban areas on the other hand, the share of buses and shorter freight vehicles is higher.

Hovi et al. (2017) have executed a survey of how the databases of the national road authority in Norway, Statens vegvesen, can be used for urban freight analysis. These include the databases Autosys, a register of the vehicles, periodic vehicle controls used for vehicle lengths, road traffic counts and travel time data. To some extent, they also used toll passings. The authors combined the periodic vehicle controls with technical information from Autosys, enabling the analysis of the freight vehicles in different urban areas categorized by their function. They also point out that statistics from SSB could be used. Using toll passings do, however, have some restrictions related to privacy and human resources needed to get the data (Presttun et al., 2018).

Transport data
Transport data is related to the commodity flows.

The Varetransportundersøkelse (Freight transport survey) provides some data on commodity flows between cities, but not internally in a city. Furthermore, it provides information on the freight volumes, and not the transport flows. This is to some degree relevant for city logistics and urban freight data, where the flows are relevant. Furthermore, the information about vehicle type is not detailed, as the few who stated the vehicle type only said "truck", and the sample of the survey does not include the freight transport done with vans, which constitute important traffic for urban freight measurement analyzes (Hovi et al. (2016), Presttun et al. (2018)). As the statistics are meant for national levels, there is large uncertainty on a smaller scale, such as in cities (Presttun et al., 2018).

Lastebilundersøkelsen (Truck survey) presents statistics on trucks with load above 3.5 tons and total weight below 35 tons, and gives information on trips and shipments. For each shipment, the type of freight, the tons transported and ares of origin and destination of the shipment is given (Natvig et al., 2016). The level of detail in time is weekdays, and the level of detail geographically is municipality (Hovi et al. (2016); Natvig et al. (2016)). The aggregated numbers are open source/available, while access to the detailed information for research purposes can be applied for. The data can be used for calculating freight volumes nationally, but not to calculate freight volumes on a detailed geographical level, especially more detailed than county (Hovi et al., 2016). The statistics do not include information on the transport chains, only the terminals that are the origin and destination of the shipment. If a shipment is repacked at that terminal, this information is lost (Natvig et al., 2016). The reporting is done continuously, with increased detail in reporting of points of loading and unloading on postal codes, contributing to increased knowledge on this (Presttun et al., 2018).

Statistisk sentralbyrå (SSB) also have statistics for vans, i.e. freight vehicles with a load below 3.5 tons, as these are not included in the truck survey. This statistics include information on transport volume for different types of vans, the type of transport, freight and client. The surveys were executed in 2008 and 2015, in relation to projects, and thus not necessarily with specific time intervals. A TØI-project called CraftTrans have researched vans and presented a survey in 2015 for counties and 14 urban areas (Natvig et al., 2016).

On a higher level, planners have access to data from the national freight model, "den nasjonale godsmodellen" (NGM), with a resolution on municipality level, and district level in the largest towns. NGM is primarily developed to give information on a macro scale. Even though it is based on zones, this division is not detailed enough for analyzing transport flows within urban areas (Hansen et al., 2017).

Data from carriers

Operators of urban freight transport are typically reluctant to share data, in fear of it being picked up by the competitors and reducing their ability to compete (Steenberghen et al., 2013). Data from carriers is therefore not publicly available, but have been obtained on project basis. Some of these projects are presented in order to describe how the data can be, when it is obtained, as an indication of what can possibly be available.

Several projects have obtained delivery data sets from urban freight operators. The experience of some of these were:

- Hovi et al. (2016) describes how the databases of the actors in the urban freight transport increasingly can provide transport data that can be used to complete the freight data that is available and verify transport models. These are databases from all of the actors directly involved in the freight, which can give insight into trip chains and trips, such as the vehicle, routes and freight, providing information of and being the source of information on what freight is transported with what vehicles and how efficient the transports are. The type and content of data they collect vary, but many of the companies keep track of shipments, form of transport, IDs, timestamps and volume and weight of the freight, and especially for the outgoing transport. Furthermore, Hovi et al. (2016) describe that the trend is registering more data, since the customers demand this data, and the registering to an increasing degree happens automatically. In addition, the systems of the companies are often able to include more data, as long as it is recorded, as well as being adapted to a defined format, if there was a standard (Hovi et al., 2016).
- Tørset et al. (2020) have obtained access to a data set from a carrier, and describe the available data in this data set. The data shows the date and time for the start of the delivery chain for a truck, the vehicle id, description of the route, as well as the zip code of the customer/destination. A time window is given for the delivery, as well as the actual time of arrival at the customer. The weight, volume or type of the freight was not given in the data set. This data has potential to represent commodity flows in transport models for urban freight transport (Tørset et al., 2020).
- Moltzau (2020) also uses a data set from freight carriers, specifically from the Norwegian post distributor Posten. The data covers deliveries done in one month of 2020. The data on the deliveries included information on weight, volume, origin, destination and delivery date. The data was not standardized, and therefore required a lot of processing in order to be able to use it, as a lot of information was reported manually and the reporting was not fully structured, leading to addresses spelled differently etc. When the data is to be used in data programs, this is a problem. If the data had been standardized when it was reported, a lot of time and effort of recoding the data would have been saved. Based on the work, Moltzau (2020, p. 36) recommends cooperation among stakeholders to develop common standards for data like this. This might be an advantage for those collecting the data themselves, as well to enable research on innovative solutions in urban freight transport. She mentions how "setting requirements on how the data can be standardized contributes to make it usable in research and studies".

This way of collecting data can provide detailed information and large quantity of data within the geographical area the databases represent. However, it might be difficult to identify the total population, and as the data is not collected according to a plan for representativeness across the country, this data is not suited for national estimates (Hovi et al., 2016). It is therefore useful for the area of which the data cover, but not so suitable for

generalization. The article assumes that as it becomes easier for the companies to provide the data from their systems, access to more complete data sets is enabled.

Other types of data than only delivery data sets have been obtained as well:

- Natvig et al. (2016) have interviewed actors in the freight supply chain, specifically the largest freight forwarders/wholesalers. Furthermore, what data the actors have access to varies, but many of the large actors have a lot of data, and the availability is increasing. Many of the actors have information on the IDs, as they are important for their own operation, but when the freight/packages are reported varies. Most of the freight forwarders have information on volume and weight of the packages transported. The mode of transport is often known. The freight forwarders do not have information on the value of the freight, and only some know whether it is dangerous freight. Many of their systems have data on number of vehicles in different corridors, that is used for planning routes. This could be used to e.g. verify freight data.
- Andersen (2020) have obtained data from the home delivery service for online shopping Porterbuddy on their operation in Oslo and the surrounding areas. The data was daily transport reports (kjørerapporter) from January until September 2020, and included information on number of orders per day, the number of trips (from their hub to a customer) for deliveries, the vehicle type used and the distance they had driven. This data enabled among other analyzes on the distribution of orders and trips over the weeks and weekdays, showing the trend for when most orders/trips were done, as well as relation between trips and orders, indicating how efficient the planning is. Furthermore, the relation between driven kilometres and orders, by different vehicle types, is analyzed. This enables to seeing the kilometres driven in relation to the total number of orders as well, as the related weeks can be compared. The data analysis gave new knowledge on the operation of the home deliveries, and shows how there is potential in utilizing operational data. However, Andersen (2020, p. 3) is clear on the fact that the work is content specific and dependent on a set of assumptions, and "can not be used to say anything generic about different delivery solutions", or E-commerce in itself, and the data gave information only on the last leg of the transport chain.
- LIMCO is a project investigating the challenge of increasing the efficiency and reducing the negative effects on the environment from goods transport by using new data (Hovi and Mjøsund, 2019). They are looking at the not yet exploited potential of data from transport and environment for planning and optimizing transport, acquiring new insights on how to utilize the already existing data from different sources, in turn giving insights into the freight transport sector. This is done by cooperating with transport- and logistics companies to get access to data and ensure relevance among the businesses. They have ongoing data collection from 620 freight vehicles, among nine actors in the supply chain. The work combines data from trucks, companies and public authorities to answer a set of questions (Hovi and Mjøsund, 2019). This shows that it is possible to get data from the companies in Norway. However, they describe one challenge being that the tracking data and sensor data have different time resolution, where the tracking data has high resolution, and the sensor data only being available with a daily resolution, as well as the API's of the trucks not containing information of the vehicle's weight, limiting their analysis potential (Hovi and Mjøsund, 2019). Furthermore, their way of handling data gives an indication on what is needed to get data. The vehicle data was identified and do not include data on the driver. The most detailed information included data on stop pattern based on delivery pattern and driver behaviour. The data was joined to the vehicle register to gain information on the technical specifications of the vehicle (Hovi and Mjøsund, 2019).
- Urban Puzzle is a pilot project executed by Sintef from June to September 2017, where the purpose was to get knowledge on the freight transport (næringstransport) in the Trondheim region, with the main focus being Trondheim municipality. The project was a collaboration between Sintef, the county, municipality and national road authorities. The idea was to "attack" the complex freight transport by collecting data from the carriers, starting with the largest actors, as it would give the most information for the least efforts, with increasing efforts per information as the actors are smaller, as well as the

largest actors having more control on their movements. During the process of getting the data, they discovered some challenges. One being on which level of the carriers organization to ask, in order to find the person with the right access to data and knowledge. Furthermore, how important it is to convince them the benefits for all when the authorities have information on the traffic - i.e. describing why they should get data and what it would be used for. In the end, they got data from six carriers, which included dynamic data (position and speed) and data on the transport (freight type, vehicle type etc.). They contacted more, indicating a variety in the willingness to share data. They also asked for GPS-data, but the possibility of saving position data was not widespread, and GPS-data therefore not easily available. From the delivery data, they could simulate routes, assuming the drivers always chose the fastest route. GPS-data would on the other hand show the actual routes, and rule out the potential error in this assumption. They discovered that large parts of the city distribution follow standard routes, with relatively fixed delivery times. The data included timestamps/date, freight type, delivery address and order. Some of the delivery data did not enable routing, but having the coordinates for these deliveries enabled seeing the delivery density. Visualizations using GIS-tools showing the density and number of vehicles per road link were produced (Hjelkrem, O. A. and Bjørgen, A., 2017). The first shows where the demand for loading/unloading facilities is the highest, and adequate facilities are the most important, to reduce inefficiency and accident risk, while the latter indicates which road links are the most important to have high standard and avoid queues. Their project showed that the collected data gave relatively good insights into the freight transport. For future development the data collection could be repeated to show the development over time or be extended to include larger or other geographical areas. Data from more carriers or more sources, such as GPS-units, apps or traffic counts could also be included (Hjelkrem, O. A. and Bjørgen, A., 2017).

2.7 Urban freight data gaps

The available urban freight transport data do not give an overview on the total number of freight trips, and what the share of traffic that is freight transport in cities is. Furthermore, the delays or inconvenience the freight carriers experience, related to the performance of the transport system and competitiveness of the city in this way, is not known. This is information that could enable better planning of restrictions and design of the city logistics systems, providing more efficient solutions for all actors, as well as evaluation of measures. Several studies have been researching what the data gaps are.

Hovi et al. (2016) have done a study of the data basis for freight transport in Norway. Hovi et al. (2016) (2016, p. 49) point out how:

"As the demand for more detailed data and transport models is increasing, especially for suburban areas, more accurate information from individual vehicles, vessels and locations is desirable to obtain a source of information that is detailed in terms of geography, time variations and vehicle type".

Browne and Allen (2006*a*) conducted a study through the BESTUFS project, where they reviewed data requirements and availability at EU level. 78 freight experts from eleven European countries surveyed were asked about the availability of a set of urban freight data in their country. A range of common urban freight data gaps were identified by the experts:

- Data about light goods vehicle activity (i.e. up to 3.5 tons gross weight).
- Data about the supply chain as a whole (i.e. the links between urban freight activity and the freight activity upstream in the supply chain).
- Data about freight and logistics infrastructure to and from which urban freight activity takes place.
- Sectoral data about urban freight activity (i.e. much urban freight data does not distinguish the type of supply chain involved and goods carried).
- Data about loading and unloading operations and infrastructure for freight vehicles.

- Insufficient geographical detail about freight vehicle trips in urban areas.
- Data collection concerning the trips carried out by consumers for the purposes of shopping (which is a form of urban freight transport but which is often not defined as such for the purposes of urban freight data collection exercises).
- Insufficient freight data for non-road modes.
- Often relatively little information is available about how data was collected and processed, and about the reliability of the data.

Data such as concerning operating costs, the structure of freight transport and logistics industry and goods vehicle data from tracking systems in the vehicles, is only collected by the private sector, and not available for the public (Browne and Allen, 2006*a*). This also goes for information such as the kind of deliveries, transport routes and cargo space utilization (Stanisław et al., 2013). The companies want to maintain their position in a competitive market and have therefore traditionally not been willing to share the data.

Natvig et al. (2016) have investigated the freight data available in Norway. They interviewed actors in the freight transport on what wishes and challenges they have for the collection and availability of freight data. Firstly, actors involved in work with the transport models and transport plans were interviewed to map the current availability of data and use of this data. Then, the private companies in freight (transportnæringen) was interviewed to map possible access to data, and lastly suppliers of technology were interviewed in order to map the possibility of their systems to support the reporting of data. The challenges of the data are presented as the level of geographic detail, as well as location and zonal division, where ward (grunnkrets) or postal codes are wanted. Furthermore, the load types (lasttyper) and freight grouping (varegruppering) must be common across modes of transport, and in line with the requirements nationally and internationally. The quantification of the freight is also a challenge. The mass is always required, whereas the volume is important for information on cost of transport, degree of utilization and calculation of number of vehicles needed. There are challenges with the transport chains, as data on the whole transport chain, including all modes of transport and potential consolidations or de-consolidations. Furthermore, the data on the trips and clustered (samlastet) data should be coordinated across mode of transport, and data on the content of the vehicles and clusters are important. Furthermore, data on events that occurs is a challenge, being reported manually today, if reported. This information is especially important for city distribution, and precise data through e.g. tracking technology that automatically registers events is favourable. Data on transport costs is commercially sensitive for the carriers, will be difficult to access and may therefore not be obtained. Data on the value of the freight is also wanted, as it will indicate the actual value of improved transport infrastructure for the freight transport. However, this information can also be sensitive, but they wish for it to be included, since "this may be in the actors' own interest as information on product value will shed light on the real value of a better transport infrastructure for freight transport" (Natvig et al., 2016, p. 27). Data on fuel emission that is based on average consumption and estimated on driven kilometres is also wanted. With regards to related statistics, they want unique links between all data elements reported, with common solutions for reporting for vans and trucks. Furthermore, the lacking link between freight flows and trips is pointed out, and they want the freight to be identified in shipments, and the same freight and vehicles to be able to be identified across reports. In addition, they want coordination between the data from the different modes of transport, and coordinated reporting from all transport modes, which fulfil the requirements of Eurostat with common coding (Natvig et al., 2016).

2.8 Urban freight data collection

Challenges today

There are several challenges related to urban freight data collection. The many stakeholders have different needs and expectations, the transport is fragmented and the system have high functional complexity (Stanisław et al., 2015), leading to data acquisition being difficult (Kijewska et al., 2016).

The availability of urban freight data, as well as the regularity that it is collected, varies a lot between, and within, countries, and depending on type of data. Existing data is collected with **different data collection**

methods. When different data collection methods have been used to collect data, it creates data gaps when comparing data sets (Browne and Allen, 2006*a*). Furthermore, the data collection and processing methods are **often not described well** in urban freight data publications and reports. This makes it difficult to assess the reliability of the data, as well as comparing it to other data. Urban freight data collected by the public sector is often done on an on-going basis by the national governments, however, urban authorities tend to do this **only in conjunction with specific projects or studies**, resulting in data collection having a small sample size and not being repeated (Browne and Allen, 2006*a*). When the data collection is not repeated or periodic, it does not provide knowledge on the urban freight operation over time. This makes it difficult to benchmark between cities. The data collected by the national governments, **often has to be dis-aggregated** in order to be useful in urban analysis, which can be time consuming, costly, and in some cases impossible, depending on the data collection method and coding, and extracting the urban freight data can be difficult. This is related to the fact that the statistics is based on vehicle activity that does not specify geographical location, which could identify whether it is urban freight activity or not (Browne and Allen, 2006*a*). There is also a risk for under-recording of vehicle activity when using diary-based surveys (Browne and Allen, 2006*b*).

In the lack of needed data, surrogate measures are often used for urban freight modelling. One example of this to use employment or establishment size because total truck trip generation is unknown (Browne and Goodchild, 2013). This results in uncertain estimations, where the calculations will be wrong if the preconditions are wrong.

Specifically for Norway, Hovi et al. (2016, p. 24) point to challenges related to the available data primarily being related to "(differences in) geographic detail level, different freight groupings, quantification of the freight and lack of information on the transport chains". The lastebilundersøkelse is based on NST 2007 standard for freight groupings, while the varetransportundersøkelse groups the freight according to the classification of economic activity NACE. For freight deliveries that are clustered (samlastet), the information is given on the type of vehicle shipping the freight, and not the actual freight (Hovi et al., 2016). In the varetransportundersøkelse the origin and destination of shipments is recorded, but not the transport chain or mode (Hovi et al., 2016).

Both the varetransportundersøkelse and lastebilundersøkelse are sample surveys, which results in some challenges with regards to sample biases and inflation errors. The sample bias leads to the businesses that have reported data is given too much weight, while the companies who have not reported data is left out. On smaller geographical scales, this can lead to deviation in what volumes of freight is transported between zones. To compensate, the lastebilundersøkelse uses a mean based on several versions of the survey from different years. Varestransportundersøkelsen uses other statistics such as a register over companies and information on turnover to estimate what freight volumes are missing (Natvig et al., 2016). Data on the transport chains must be collected from those organizing the transport, while some data on the trips can be collected from those organizing the trips, but for the most part be collected from the freight carriers (transportørene) (Natvig et al., 2016).

Furthermore, **obtaining data from carriers is difficult**, due to lack of trust from the respondents, that are afraid that the data sharing will reduce their position in the market. Steenberghen et al. (2013, p. 83) point to the fact that not all data can be shared, such as data on performance, but that data released "partially or in aggregated or in anonymized from would not harm and be of great use for the public but also for policy making". Patier (2008) points out how raw data could be kept secret, but that aggregated data should be available. This indicates that asking for the "right" data, could help getting access to data. This requires knowledge on what data is needed, as well as of what data is off limits. To protect confidentiality, all identifying information is removed from the data before it is shared with the researchers (Browne and Goodchild, 2013).

Aspects to improve data collection

Browne and Allen (2006*a*) point out how data collected from different sources has to be coordinated. Data collected in various time and space scales have to be linked in order to be used for modelling and data about activity types, activity location, logistics and transport management should be collected simultaneously. Developing common standards nationally or internationally, would help making it possible to share information, compare initiatives, check solutions' transferability, and evaluate policies and efficiency of methods from one

city to another (Neghabadi et al., 2019). In order to compare cities, knowledge is needed on characteristics, typology and geography (Neghabadi et al., 2019). In order to have common data and being able to apply a model to different urban areas, the surveys have to be standardized (Patier, 2008).

The logistics chains are not isolated within the urban areas, which illustrates the need for common approach to standards, data collection and data processing at regional or national levels (Debauche, 2008). With regards to transport data from the urban freight carriers, Moltzau (2020) experienced that it was not standardized, leading to time consuming recoding of the data in order to be able to use it (see section 2.6). This is related to the fact that in order to get the full overview of the complex urban freight transport, **combining different collection methods** is necessary (van den Bossche et al., 2017).

In order for the data to be reliable and possible to use in comparisons and by others, freight data collection should be **well documented** in terms of the data collection method and reporting, including sampling, way of capture, weighting and expansion of sample, so that the results are verifiable (Browne and Allen (2006*a*); Patier and Routhier (2008)). For the data to be comparable, common urban freight transport methodologies and analyzes (including indicators) shared by the actors in urban freight are needed (Browne and Allen, 2006*a*), as well as the need of observing the same units (Patier and Routhier, 2008). This also requires data collection design with "aspects as sample frame, control of survey progress and use of cross-checks on the output of the survey results" built in (Ogden, 1992, p. 313).

Taniguchi et al. (2001, p. 52) point out the need to establish and maintain data collection programs where the **requirements and responsibilities** of all involved parties is described in order to have adequate data. This is related to the recording, concerning the frequency of updating, storage and retrieval of data, the ownership, concerning pricing, quality control (integrity) of the data and privacy, concerning the confidentiality and the security, especially related to vehicle location information. This will help tackle the problem of lack of ownership to the issues and data described.

Large-scale statuary national freight data collection will likely be important for providing urban freight insights in the future as well (Browne and Allen, 2006*a*), with a high response rate (Browne and Allen, 2006*b*) and "well developed and refined methodology and sampling approach" (Browne and Allen, 2006*a*, p. 21), as long as it is possible to **dis-aggregate** it to urban scale from the national scale. To make extraction of urban freight data possible from the national surveys/data collection, the specific geographical location should be included, so urban and non-urban can be separated, with an adequate sample size within the different geographic subareas. Too small sample size will lead to uncertainty and data reliability issues when dis-aggregating the data by geographical location, product type etc. (Browne and Allen, 2006*b*). Too small sample sizes are not statistically representative. Data from one-off data collection in urban areas, is therefore difficult to compare with other results in time or space (Browne and Allen, 2006*a*). In addition, trips taking place inside and outside urban areas are not coded in a way that they can be classified as either vehicle activity that is urban or not. The ways the data is coded will therefore also determine what insight this data will give for urban freight (Browne and Allen, 2006*a*).

Natvig et al. (2016), have, as described, interviewed stakeholders on the availability and use of data from private actors. Their interviews gave insight to the fact that the largest actors have their own tailor-made solutions, and they decide the development of these themselves. They conclude that there is large potential in **collecting data from the systems of urban freight operators**, but the systems will need to be adapted in order to deliver data that follows a standard on what data should be reported and what format they should have. To improve the process, they would like legislation and guidelines on who is required to report, when, how it should be reported and what data elements that should be reported. It would be an advantage in the market to provide data if there was legislation demanding it (if included in statistikkloven) Related to challenges of data processing, comprehensive data collection with a sample that is sufficient to minimize sample biases, will enable reliable data inflation to national level, and help reduce the problems of sample bias and inflation errors. To tackle the problem of many different formats and levels of detail, data from different sources should be collected with uniform format and level of detail. They also point out that other sources than reported data is needed to verify and complete the freight transport models in analyzes (Natvig et al., 2016).

Aifandopoulou and Xenou (2019, p. 21) point out that to be able to act on urban freight transport problems, knowledge on the urban freight transport is needed, and thus propose for the local authorities to collect certain data regularly describing the freight transport. Since the municipalities are in charge of handing out operational licenses for the majority of activities generating freight transport, this can be achieved by "engaging the transport and logistics industry actors in regular data provision process", and "it is recommended to add the obligation for data provision (i.e. twice or three times per year) to the operational license maintaining procedure. In case of a specific geographical area intervention, it was also found efficient to relate data provision to area access permission", in line with the findings of Natvig et al. (2016).

When collecting data, it is important to collect the data that is most important, based on a **prioritization** of urban freight data gaps and needs (Browne and Allen, 2006*a*). The information should be relevant to explicit policy or planning needs (Ogden, 1992, p. 313), with regards to the authorities and planners. This is related to considering what data that is basic and need to be collected, and what data that can be derived from other data (Patier, 2008). Unique and complete IDs are important in order to link data from different sources. To reduce costs, a clear statement of need is required before collecting data, to ensure only useful data that actually will be used is collected (Ogden, 1992, p. 308). Currently, a statement of needs and why it is needed is used for privacy and security reasons before collecting data, and the data can only be used for what it is collected for.

In France, approaches for data collection and modelling are designed simultaneously, and at national level. They execute large surveys and register the data in common registers, which is possible because of funding from the state (Sonntag and Meimbresse, 2008). This shows how integrated data planning is useful, and the importance of acknowledgement of the issue from the top level.

New technology affecting data collection

New information technology that could be used for urban freight data collection by creating large volumes of data is being developed (Steenberghen et al., 2013). This gives potential for collecting significant quantities at lower cost than previous methods (Browne and Allen, 2006*a*). For example cameras and RFID-technology could be used to collect tracking information, on the origin of the freight or the relations of re-packing (omlasting) (Debauche (2008); Mjøsund et al. (2020)), as well as satellite tracking, roadside camera and weigh-in-motion data (Browne and Allen, 2006*a*). New vehicle technology automatically stores a lot of information about the driving, such as speed and fuel consumption, and many carriers track their vehicles with GPS (Fossheim et al., 2017). GPS modules can be placed on freight vehicles and used to pick the least congested route when driving in the city. Furthermore, GPS-data can be used to identify route choices, when the vehicles are driving, the location of bottlenecks and how long the vehicles stop for deliveries (Hovi and Mjøsund, 2019). The aim of the involved actors is to exploit the informative and financial benefits this technology gives (Otte and Meisen, 2020). This is useful for planning for efficient and sustainable city logistics.

However, there are some challenges with the application of the new technology. When this kind of data collection methods are used, privacy issues and commercial interests are among the problems that arise (Debauche, 2008). Steenberghen et al. (2013) point to the risks of not having capacity to process the data, technical barriers, such as data formats or institutional, limiting the data sharing ability, privacy concerns and liability concerns related to data generated by information technology. Most of the data collected from the new technology is collected by the private sector. This brings potential, as this data is useful/valuable for the other stakeholders, but illustrates a core of the data challenges described, namely getting access to the data from the private actors. Browne and Allen (2006*a*) mention the considerations of whether it is legal, as different countries have different regulations; the need of supplementing it with other data, as it often does not provide all the data that is collected in traditional surveys; and a need for co-operation and agreement between the private and public sector to share the data and integrating it into existing data. The sensor or tracking data does for example not say anything about the trip purpose or goods transported.

Furthermore, when deploying vehicles with e.g. GPS, or analyzing data from a set of GPSs, the data sets only include vehicles with the gadgets implemented. Assessing the proportion of these vehicles in the total urban freight flow in the urban area in order to know what level of the total freight transport the data can give

information on is therefore needed (Browne and Allen, 2006*b*). This applies to other technology as well.

Another challenge is the cost of the technology, which can be a barrier for high penetration of usage among the carriers. For example, Mjøsund et al. (2020) mention how RFID still is an expensive technology, and therefore only is used for valuable freight or more aggregated level, not shipment level. However, the cost is likely to be reduced as new technology is developed, and the trend is increased usage. Furthermore, they point out how most of these new technologies do not include info on the freight type.

As data from many new sources becomes available, it enables the possibility for more and higher quality data, but it increases the requirements for processing. The process of verifying and analyzing data can be complex with a lot of data coming from many data sources. Techniques for analyzing big data, such as Complex Event Processing (CEP) will thus be useful. CEP combines and interprets data from different sources, often based on timestamps (Hovi et al., 2016). Hovi et al. (2016) describes the example of how combining reported freight data, traffic counts along the network, tracking data from carriers and carriers and data from toll stations as well as other statistics, such as SSB, can give a more complete picture of the freight transport.

Langeland (2021) have researched mega-trends affecting the future of transport, including a national survey among freight actors as part of the project DIGMOB. The survey was on use and experiences of digitization, specifically challenges and trends they think will affect them, including just below 1000 respondents, both supplying and demanding services. The results are shown in figure 2.4. 70% say they use digital technology. The freight actors were asked on the opportunities they thought digitization of transport services would provide their company over the next years. They see the most potential for increased transport efficiency, reduced costs and increased resource efficiency. Around 70% of the respondents answer that this will affect them to a large degree or some degree. Only 5-10% think that these trends are not relevant for them, and 50% or more think that all of the mentioned trends will affect them to some degree or more.

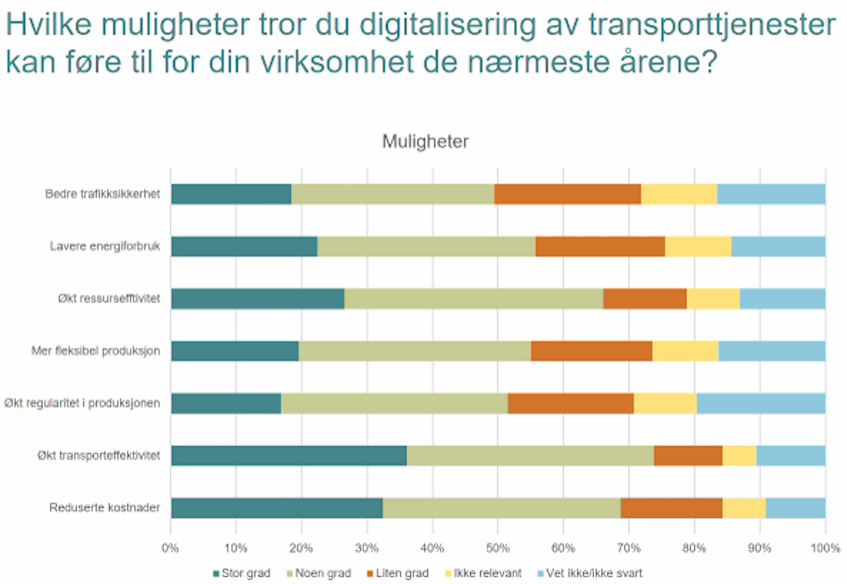

Figure 2.4: Opportunities carriers think digitization of transport services will give their companies from a survey conducted by Langeland (2021).

The challenges seen by the respondents are shown in figure 2.5. The challenges are mostly related to costly economical investments and lack of technological competence, with over 60% thinking that this will be challenging to a large or some degree.

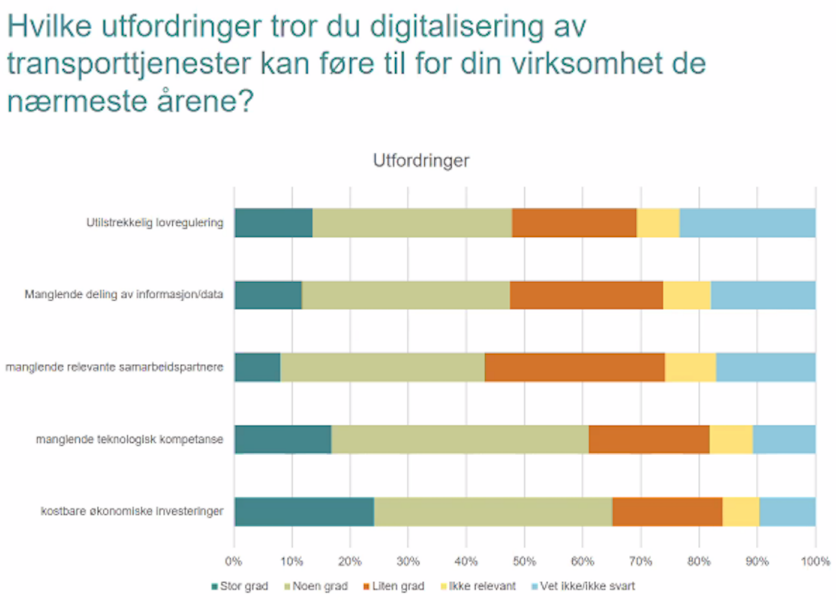

Figure 2.5: Challenges carriers think digitization of transport services will give their companies from a survey conducted by Langeland (2021).

This shows that the urban freight companies are paying attention to the technological development, and how they think technology will benefit them. Furthermore, it is an indication of factors to be aware of when starting to attempt to or to utilize the technological developments, in order to maximize the possibilities and minimize the challenges for the actors.

Automation of data extraction

Hovi et al. (2016) highlights the potential of automated extraction of data from the data bases of companies involved in freight, in order to get high quality data on freight transport that is detailed enough for urban freight transport analyzes. In order to use automation, they point out that the data collected across means of transport should have common format, common lists of codes, or codes that can be related to each other, and IDs that are the same throughout the whole transport chain be striven for. With these methods, the data process efforts are greatly reduced, and more data can be collected and analyzed, enabling big data analyzes. The IDs are important for enabling the connection on the transport chain of the freight and how the trip was executed, as well as making it possible to identify and correct wrongful reports, thus enabling data collection that is more robust (Hovi et al., 2016), and give data that are valuable.

Stakeholder collaboration - getting data from the private companies

Mjøsund et al. (2020) point out how the potential of "big data" owned by private companies is only released when it is integrated with data on the infrastructure and traffic owned by the public. Browne and Allen (2006*a*) point out the importance of collaboration for data sharing and management between the public and private sector in order to be able to benefit from a lot of the data collected with new technology. Browne and Allen (2006*a*, p. 26) state that "public organizations need to work closely with these private companies to overcome issues concerned with funding and confidentiality in order to obtain access to it". Developing Public Private Partnerships is "essential in order to obtain useful data and to involve the companies in return" (Patier and Routhier, 2008, p. 45).

The advantages of cooperation between public and private sectors by joint working and planning, include according to Allen and Browne (2016, p. 101) "the early identification of urban freight problems, improved urban freight strategy and policy development, the avoidance of unintended policy consequences, and more successful outcomes from urban freight policy initiatives" contributing to "better urban freight policies, improved policy compliance, higher levels of vehicle efficiency and more sustainable urban freight operations than would

otherwise have been the case".

European Commission (2013, p. 5) suggests for the European Union member state to create "platforms for cooperation, exchange of data and information, training, etc., for all actors of urban logistics chains", illustrating the need for collaboration in order to ensure efficiency.

Stakeholder collaboration enabling better data collection does not only count for the public and private sector. Even within the public sector, there is currently lack of coordination between tiers of the government on collecting freight data Browne and Allen (2006*a*). Working more closely together would provide smarter use of existing resources.

An example of stakeholder collaboration in Norway is "Elskede by", where the three companies Bring (Third-party logistics provider), Ragn-Sells (in renovation) and KLP Eiendom (private actors, developers) are collaborating on distributing freight with electric vehicles from a hub in the central part of Oslo, and bringing waste back on the return. KLP Eiendom rents out the building that the hub is located in. The concept has been tested in Stockholm, Sweden, and the CO2-emission was reduced 73% for the relevant transport (Ivarson, 2019). Tungt.no presents the project, and have interviewed the CEOs of the collaborating parties. The CEO of Ragn-Sells, Bjørn Hoel, says that he contacted the municipality in Oslo after the success in Stockholm, and the two other actors agreed to join shortly after. The CEO of Posten (Bring is part of Posten), Tone Wille, points to the fact that both Ragn-Sells and themselves have ambitious goals related to climate and environment being the reason for them to join this project - "It is simply a matter of making Oslo an even better city to live in, at the same time as we must make arrangements so that you can also run a business in the city centre" (Ivarson, 2019, paragraph 4). Furthermore, she highlights how they want to be proactive at finding sustainable solutions, and experience willingness from the municipality in finding solutions that work for Posten's customers. In the article the Governing Mayor of Oslo, by Raymond Johansen, is sited saying that the municipality of Oslo have no possibility of improving the air quality or reduce greenhouse gas emission without a close collaboration with the private business actors (næringslivet) (Ivarson, 2019). This example shows how collaboration between the stakeholders is needed to contribute to reduce negative impacts from the freight transport. Already after some months in operation, Tungt.no reports that the emissions for the transport in Elskede by is reduced with 50%, and the project has been expanded to Trondheim (Ivarson, 2020).

2.9 Getting data from private companies

It has been described how obtaining data from private companies can be difficult. The aspect of obtaining data from private companies, such as carriers, will now be elaborated.

Allen and Browne (2016, p. 101) point out how "it is important that these partnerships [between public and private sectors] are established on the basis of **creating mutual benefits for the public as well as the private sectors** if they are to succeed – some such partnerships that have failed have demonstrated that achieving this balanced outcome that meets the needs of all parties is crucial to successful cooperation between the public and private sectors". This includes developing business-models leading to a win-win for the involved stakeholders (van den Bossche et al., 2017).

The literature points out the need for **incentives** to get private companies to share data (Patier (2008); Steenberghen et al. (2013)). This can for example be by making provisions for data collection in contracts, with incentives such as funding the data collection, as well as promoting and documenting good practice (Steenberghen et al., 2013).

Natvig et al. (2016) point out how companies should be encouraged to share reported data by **informing about the advantages this will give the freight sector in the long term**, e.g. infrastructure prioritization that are in line with their needs. Furthermore, they state that freight interest groups should encourage this data sharing, as well as more efficient use of the systems and creating knowledge on how the use of these systems and automatic data collection promotes better operation and services for their customers.

In order to create interest among the actors, **different strategies are needed for the different stakeholders**,

as they have different objectives and perspectives. For the carriers, early involvement is needed, focus on specific plans and how efficiency leads to increased profits. For interest among the authorities, they need knowledge within the field, prioritizing urban freight transport and having practical guides instead of guidelines, so that they can be applied to the specific cases. For the receivers and other actors, such as public transportation companies, it has to be directly related to their company (Karlsson and Bjørgen, 2019).

To be able to collaborate on data sharing, general cooperation and dialogue is useful. Karlsson and Bjørgen (2019) therefore point out a need for **efficient channels for involvement and establishing arenas for cooperation and dialogue**.

For releasing potential of automated extraction of information from freight carriers' databases, it is important to **communicate with the companies early**, in order for the change of reporting formats to not become costly for them (Hovi et al., 2016), which will reduce their willingness. If the companies' databases do not include the wanted data, the trend is that they are willing to include it if it is demanded by customers or the transport industry, and the data can relatively easy be adapted to the wanted format (Hovi et al., 2016). As the technological solutions and automatic registrations of the trips of the carriers/freight transport companies/actors improves, the reporting of relevant data will be easier. Sharing data will have an initial cost for the companies, in order to adapt their systems and possibly collect more data than they do today, but when this is in place, data can be reported in line with the standards at no cost. In contrast, the current manual reporting also has a cost. The burden of reporting is eliminated with automated reporting. However, the actors need to be **given sufficient time to adapt and adjust their practice and systems** before introducing possible legislation. The bottom line is that it should be ensured that electronically reporting is more profitable than the current manual practice. In order to adapt the systems of the carriers (Natvig et al., 2016).

Allen and Browne (2016, p. 85) have identified success factors for partnership working in the supply chain operations on strategic, operational, ethical, legal/regulatory and technological level. On strategic level, success factors are to involve a wide range of stakeholders, within both public and private sector, among which some are senior managers. Furthermore, funding must be in place, and "'softer' solutions based on collaboration rather than regulation and restriction are likely to be more acceptable and beneficial". On operational level, a common ground and goal among the involved parties is needed, and the expectations should be realistic. To ensure results, actions are needed, and the tasks should include timescales and responsibility and roles be clear.

The **relevance of sustainable city logistics/urban freight for a sustainable development** can also be an incentive for the private companies sharing data. If it is shown how the data sharing improves the quality of life of the citizens and the environment, it can become attractive to share data and "advertised" with it. Efficient and sustainable city logistics relates to the seven UN sustainability goals, highlighted in figure 2.6. These goals are: nr. 3 - Good health and well-being, related to reducing accidents and air pollution; nr. 7 - Affordable and clean energy, related to using renewable energy; nr. 8 - Decent work and economic growth, related to good work conditions and economic productivity; nr. 9 - Industry, innovation and infrastructure, related to developing infrastructure that enables efficient freight transport; nr. 11 - Sustainable cities and communities, the aim; nr. 13 - Climate action, related to reducing the negative implications of urban freight transport; and nr. 17 - Partnership for the goals, reflecting how to solve the challenges from urban freight transport the society is facing today, new and strong partnerships between authorities, the private sector, and the rest of the society, is needed. Finding a way to encourage this collaboration, is therefore needed.

Figure 2.6: The UN Sustainable development goals sustainable urban freight can contribute to.

Langeland (2021) asked for the methods the public authorities would need to use in order to stimulate a development where the companies can utilize the technology trends for more efficient and sustainable transport services. The results are shown in figure 2.7. The respondents point to data, which is essential for digitization. More than 40% thinks that making relevant data available will be an important method to a large degree, and more than 70% to large or some degree. Furthermore, standardization, also related to data, is pointed out.

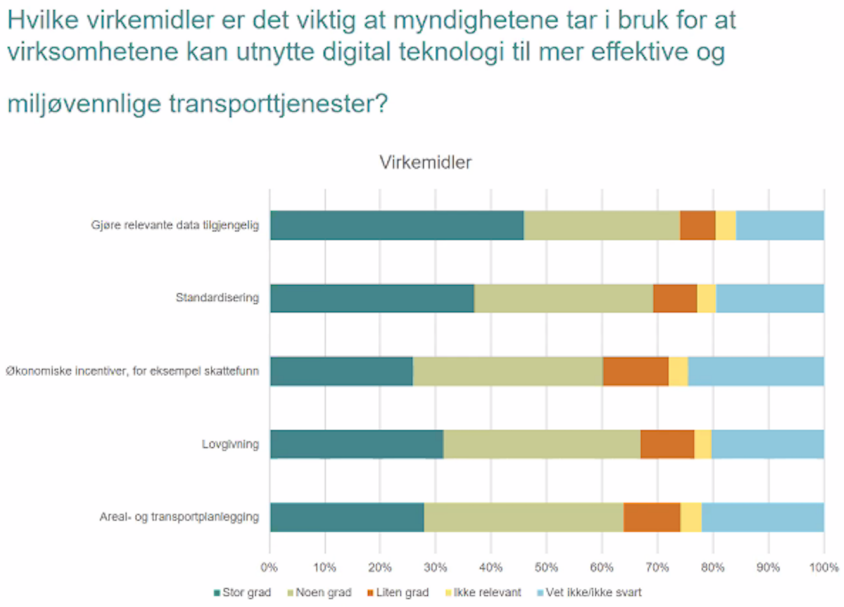

Figure 2.7: Methods urban freight actors think the public authorities could use for them to utilize technological development from on survey by Langeland (2021).

This gives an indication of what methods the private sector thinks is important, which is useful in order to ensure acceptance when they in the future plan to implement methods for data sharing.

There are examples of collaborations between public and private stakeholders where the private have been sharing data. An example of use of new technology in urban freight data collection is The Off Hour Delivery Program, a pilot program implemented in New York city, where freight carriers are provided with smart phones with GPS (Lepori et al., 2010). By tracking the smart phones, "network monitoring, dynamic pricing and data provision for freight transportation modelling and network traffic simulation and verification of user compliance" is possible. The phones also give dynamic data "used to support freight transport modelling research, as well as network traffic simulation" (Lepori et al., 2010, p. 31). This helps the authorities manage the urban freight better, and improves planning. As a benefit for the freight carriers, dynamic data on the network conditions can be shared through the phones to the transport operators allowing them to use dynamic fleet management

at a low cost (Lepori et al., 2010), enabling more time and resource efficient operations. Based on this example from New York city, not only using the data from the private companies, but also providing them the data enabling more profit, could be a good recipe.

Transport for London has a project called "Data for London". The aim is to "promote collaboration and data-sharing to generate insights that will lead to better policy decision making and have a positive impact on the lives of Londoners" (London Data Commision, 2020, p. 3). The background for the project was the acknowledgement that London is not utilizing the currently available data the best way they could, as a lot of data is collected, but much of this is fragmented across public institutions and not accessible, or difficult to access, being held by the corporations (London Data Commision, 2020). They state that 90% of the collected data is not looked at again, indicating significant potential for using it better. They have defined which critical areas would be efficient to address with currently available data, and sustainable transport is one of these. The program does not focus specifically on urban freight transport, but the principles of data sharing they have found among other private public collaborations, can be relevant to learn from when wanting to facilitate this specifically for urban freight as well. As part of the work, Transport for London wanted to find out what the incentives for private sector organizations to share and open their data were, as well as the barriers preventing it now. They found that in general there was a positive attitude among the private sector to share data, especially where it "achieved corporate social responsibility objectives, equally commercially sensitive and competitive advantages", as these "were important considerations in their willingness to engage" (London Data Commision, 2020, p. 4). As part of the work, they have identified "five critical success factors for facilitating successful data-sharing pilots", that likely can be applied to other cities (London Data Commision, 2020, p. 26):

- Find alignment with corporate objectives of pilots' participants and data providers.
- Ensure continual focus on long-term benefits for citizens.
- Define data-sharing principles early.
- Establish commitment of the pilots' participants to action plans.
- Set up a data-sharing agreement template.

The examples mentioned from New York city and London illustrate giving analyzes in return for data exchange (and in London's case involvement). In addition, exchange of data could be possible incentive to share data, if the municipalities/researchers have data the private stakeholders need. It is important to make them see it as benefit for the society to contribute with data for more sustainable freight with less negative impacts.

2.10 The future of urban freight transport

Similar to other aspects of transport and the society, city logistics is experiencing changes due to new technology and other external trends. It is important to be aware of the existence of these trends, and to a certain degree understand and predict, as much as possible, the effect they will have on city logistics. Some trends are happening gradually, while others are disruptive, and more difficult to predict. Regardless, the trends will affect the future freight commodities (varestrømmer), costs and freight transport modes and alternative choices, in turn affecting, and having to be incorporated in, transport models that aim to describe the freight transport market and develop prognosis and scenarios (Mjøsund et al., 2020). Furthermore, the trends are presented to provide an understanding of how the data needs and application might change even more over time in the future, and flexibility in the model will make the model more applicable. Having a picture of possible trends and their effect on the city logistics and urban freight transport is necessary to develop good policies, regulations and measures (Presttun et al., 2018).

Technological trends

The survey conducted as part of DIGMOB by Langeland (2021) also give insights into what technological trends the actors in freight thinks are the most important for affecting the company or the demand for their company in the future. Their results are shown in figure 2.8. The figure shows that more than half think that

digitization is the most important trend, affecting to 50% to a large degree, while 80% thinks it will affect to a large degree or some degree.

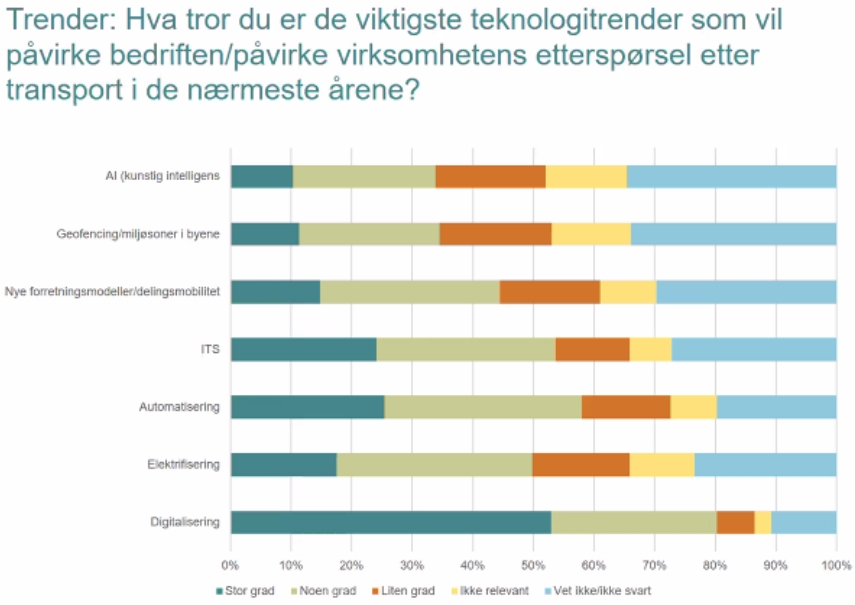

Figure 2.8: Technology trends.

Seeing the relation between these trends and the methods that the authorities have to exploit the potential in technical trends, it indicates the importance of standardized and available data, as well as regulation.

Intelligent transport systems (ITS): The new technology discussed as potential aspects improving data collection, will likely be deployed as part of increasing degree of ITS. Regarding the impact of ITS on mobility, MDS Transmodal (2012, p. 132) states:

"The deployment of ITS in urban areas could have a significant positive impact on urban mobility as a whole as it would allow urban freight transport operators to react to urban traffic conditions in real time and so reduce road congestion and smooth traffic flows. The key issue could be the cost of capital expenditure and operating costs involved unless costs can be recovered through user charges".

This means that to enable efficient ITS, data sharing must be in place.

Internet Of Things (IOT): Internet of things is another trend that is likely to affect the future of transport, including freight transport. New possibilities of tracking enable access to information on the status on freight, processes and activities throughout the supply chain. Constant data stream that makes the companies able to focus on efficiency and planning instead of monitoring, warnings and reactive actions on faults (Rindli, 2016). Not only the vehicles can be tracked, also the packages themselves. Combined with e.g. information on what type of freight the package is, this data would give insight to how different types of freight are transported, e.g. whether the route choices are different, how they are grouped etc. Since IOT is making the urban freight distribution more effective - it is likely that most companies will use it, and thus collect a lot of data. When the systems of the freight transport operators are already collected and sent to the cloud - they only need to give access to those who could extract it to a model. The data can possibly be updated in real time, and certainly at a quite high frequency.

IOT can produce big data - which requires the ability and capacity to store and process and analyze data. Artificial intelligence (AI) and machine learning can be used for analysis to help analyze and predict. At a seminar held in Norway in May 2020 arranged by BI and LOGMA, it was pointed out that when "different/various data is made available through cloud based solutions, they can be retrieved together, seen in relation of each other

and provide increased understanding of overall/total processes" (Flygansvær, 2020, paragraph 4). This further indicates the potential that IOT and other technology have for the companies, and how it likely will affect the future.

More precise information from the systems lead to more reliable basis for decision, and automation of critical operations to more stable operation. The trends such as increased e-commerce, home deliveries and expectations of fast delivery, creates a dilemma between quick transport with short delivery times, versus more route based and cost efficient transport. A better basis for decisions will improve the route planning and fleet management, and balancing this dilemma.

Autonomous vehicles: If trucks and vans in the future are connected and autonomous it requires reliable and efficient platforms for communication and interaction. Automation of the costly "last mile" will remove the cost of the driver, increasing the revenue for the carriers (Presttun et al., 2018). This also requires sensors and data that continuously generate data, that is analyzed and used for the vehicles to navigate. This data will likely be in the cloud, so it is related to IOT and ITS. As systems for this is developed, it creates potential for the municipalities and researchers to meet the development in advance and help create systems that share data for the purpose of improving the infrastructure and operation, by e.g. asking for certain data from the communication systems that is needed for urban freight transport modelling. The literature points to the fact that better planning and use of models will lead to better exploitation of the whole supply chain and adapting the capacity at every step.

Social trends

Increase and change in E-commerce: Online shopping is making life easier for people, but may have negative consequences for the city that are not foreseen, and not taken responsibility for. More online shopping increases the number of deliveries, especially home deliveries, and thus the need for curb space for parking when delivering, storage of packages located at a good place, and increases truck traffic, possibly on residential streets not planned for a lot of truck traffic (Pitera, 2020). The delivery solution will have effect on the magnitude of the consequences, e.g. whether the deliveries are made to the consumers homes or a pick-up location. Regardless, this leads to new and other urban freight movements and distribution patterns (Bjørgen, 2020), that needs to be planned for, if going to be solved in a sustainable way. Furthermore, increase in e-commerce leads to increase in returns (Presttun et al., 2018).

Numbers from Statistisk sentralbyrå (SSB) show that there is a tendency among Norwegians of more purchases for lower values (Frøberg, 2020). This can increase the volume of urban freight transport, if not planned for the opposite. Presttun (2019) also points to how the commerce is changing, and large increase in small deliveries and more de-centralized storage structure is expected.

A study by Nenseth and Klimek (2019) researching mobility changes as a result of new purchasing concepts, identifies several changes that will affect urban freight transport. A flexible network of smaller warehouses will replace large centralized warehouses, and these smaller warehouses and shops will be more important as distribution centres. Furthermore, they conclude that the freight delivery will be more personalized, with smaller volumes and higher frequency than the original commodity flows. They point out how it is important to make sure this does not lead to unintentional and negative impacts, as discussed. Furthermore, they state that the dependency between actors will increase, as no actor can make sustainable development on their own. They also raise the question "Will, for example, consumers' increased expectations of convenient, flexible and fast delivery outweigh the economies of scale of freight transport?" (Nenseth and Klimek, 2019, p. 32). Furthermore, Nenseth and Klimek (2019) point out how the digital competence of consumers, producers and suppliers is important for exploiting the social, economic and environmental advantages of these purchasing concept changes. The expectations and demands for fast deliveries are increasing (Presttun, 2019).

Fragmentation and new distribution solutions: To meet the trend of more E-commerce and home deliveries, and demand for faster deliveries, new concepts of distribution are being developed. One example is "Porterbuddy", a home delivery service for online shopping. Storages and online stores send their packages to them, and Porterbuddy distributes them. This is done to streamline the delivery home to the customers, as efficiency

is seen as important in order to compete. They use other suppliers for the deliveries, which uses electrical vehicles and cargo bikes for efficient deliveries in urban areas without emission. They want to "make the home deliveries as green as possible and better for the environment than if you shop yourself with a car" (Solem, 2019, paragraph 3). This means that new companies are responsible for transport. In order to get a picture of the urban freight transport volume in the future, companies like Porterbuddy will likely be more important. Porterbuddy uses real time information to optimize their routes, which reduces the costs (Solem, 2019). This illustrates how utilizing new technology is profitable for the companies. Another example is Schibsted, who have introduced a new service where you can subscribe to home deliveries for a monthly sum, and then you do not have to pay extra for shipment from collaborating online stores. Schibsted will use their existing network delivering newspapers and magazines, who is already delivered home to their customers, to deliver the packages. Their network covers 90% of all door mats in Norway (Eidem and Johannessen, 2019). Furthermore, an example of new collaboration in Norway is between grocery delivery company Kolonial (now called Oda) and parcel delivery company Helthjem. Helthjem is already delivering packages with newspaper deliveries, but Kolonial will handle the larger packages in their vehicles. The companies point out how this is both more economic and sustainable, as the volume of vehicles that are already on the road will be utilized better, and more goods can be delivered more efficiently, and that they in this way can compete with the large distribution actors in Norway (Finstad, 2021).

Other solutions to adapt to the changes are consolidation centres and freight hubs, also leading to the fragmentation. This illustrates how the transport data collection have to keep up with these trends and changes in order to represent the traffic well.

Other developments towards sustainable urban freight transport, that will possibly affect it in the future, is increased awareness on the negative externalities of this freight transport. Possible solutions mentioned are giving customers the chance to consolidate their purchases with those of their neighbours, providing the chance to choose environmentally friendly shipment, and transferring part of the cost for environmentally friendly to the customer (Caspersen, 2020).

Covid-19: Covid-19 has had an effect on most aspects of society. Generally, Covid-19 contributes to speeding up some of the already seen trends, such as e-commerce. According to SSB, in the second quarter of 2020 the value purchased for online in Norway was 30% higher than in the first quarter of 2020. Furthermore, 59% of all transactions done by card in Norway was online in the second quarter of 2020, compared to 43% in 2019. This shows how the restrictions has led to e-commerce making up a larger share of the shopping. Covid-19 can lead to more people wanting to have the goods delivered to their homes to avoid going out. However, the effects of Covid-19 in the long term are not known. While some people long to going to stores to shop again, the pandemic might have introduced others to the practicality and comfort of online shopping. However, there are indications that it will lead to more e-commerce and fragmentation and home deliveries, even though it might be to a smaller degree than the increase seen now under strict restrictions.

Covid-19 have in addition showed how fast life as we know it can be disrupted. Thus, how planning for the unforeseen is an advantage. The freight companies that were prepared for the change, did better. Logistics director in Infinitum, Sten Nerland, says to the newspaper Tungt.no that "It was interesting to see how little useful historical data can be used in an extreme situation" (Førde, 2020, paragraph 2). The company has been in charge of the recycling of bottles (pant) in Norway for 20 years, and have therefore good access to historical data, that usually leads to efficient operation. During the summer of 2020, they experienced much larger volumes of bottles being recycled, and another pattern of where the bottles were recycled, due to the sudden change in peoples travel patterns. The factors that enabled them to adapt the logistics and ensure operation, was keeping updated on restrictions, recommendations and information from the tourism industry to predict where the Norwegians would spend their time and recycle their bottles, and keeping a close dialogue with the wholesalers and carriers so they could adjust and adapt the transport of the bottles. Now in the fall of 2020, the volume of recycled bottles is higher, but the pattern is back to normal (Førde, 2020). This indicates how the companies might have learned to be more flexible, and it is likely that the pandemic have lead to the future transport systems being more flexible (Langeland et al., 2021). It also shows the importance of

information flow between the actors.

Political trends

Prioritization of walking, cycling and city life in the urban areas: The trend in cities all over, and especially in Norway, where this study is based, is prioritization of walking, cycling and city life in urban areas (Presttun, 2019). This makes well planned and holistic solutions for urban freight transport by knowing their needs even more important. Without facilitating for/taking into account freight transport in planning and design of the city, the effect is less efficient deliveries, which can also lead to higher risk of accidents. However, less passenger vehicles and parking on the streets can lead to more efficient city logistics (Presttun et al., 2018). These contradicting outcomes further indicates the importance of well planned urban freight transport.

3 Method

The study is based on a combination of semi-structured interviews with professionals involved with planning and conducting urban freight transport, and analysis of urban freight transport delivery data obtained from the carriers. The interviews were conducted to understand the need for and availability of urban freight transport data in order to improve tools for analyzing urban freight transport, and the barriers and implications of obtaining and sharing data from carriers. The analysis of the delivery data from the carriers complement the interviews and were conducted in accordance with the conditions for sharing the data.

In more detail, the two methodological approaches are:

1) Interviews:

- With planners, researchers and politicians involved in city logistics, covering challenges, analytic needs and future organization of urban freight transport.
- With carriers, covering the challenges of getting their deliveries to the right place on time, data use, what data they are willing to share and under what conditions, value of data sharing and future organization of urban freight transport.

2) Data processing:

- Example data sets from the same carriers have been obtained and analyzed, in order to research what type of format they have, and how it can be used.

The aim of this was to obtain:

- A picture of the impact that access to more and better urban freight data might have on planning for sustainable city logistics. Furthermore, of what data is the most needed, in order to prioritize data collection. In addition, insight to what data is available for and used by the different stakeholders. The assumption is that the degree of data use is varied.
- What requirements the actors in the supply chain have for sharing data, so that others interested know what to ask for/how to ask in order to obtain data.
- A recommendation on what format the data should be asked for in order to be most useful, as well as a method for handling the data, identifying the potential of extracting the data to a model, providing insight into how this data could be standardized in order to be usable for research and studies.

The methodological approach is summarized in figure 3.1.

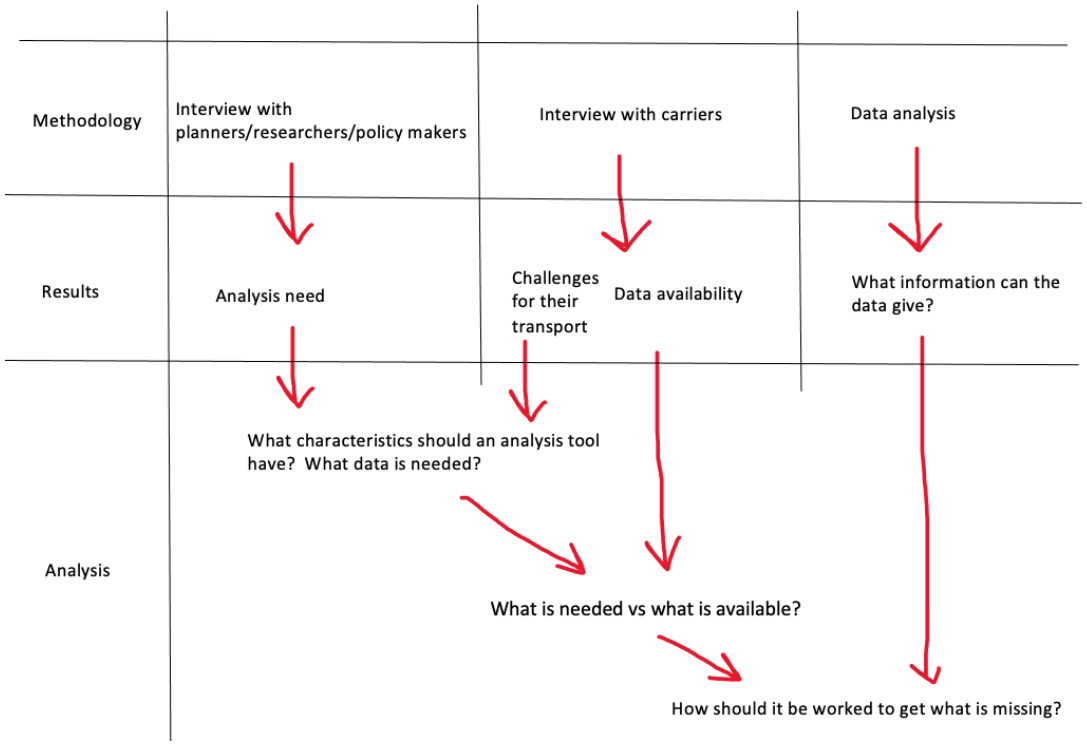

Figure 3.1: Methodological approach.

In total, this aims at contributing to a basis for a model on urban freight transport data, to be used by all actors in city logistics. Developing models is a process that takes time, and the purpose of the model have to be clear in order to develop it, validate it and continuously evaluate it (Hansen et al., 2017). Researching the analysis need is therefore valuable in order to help identify the purpose such a model should have, and the functionality built in to enable this, or even whether a model is the right choice.

3.1 Choice of method

Qualitative method

The method is qualitative both in terms of the interviews and the data analysis, as the purpose is to create a "deeper understanding of the problem one is studying" with "small degree of formalization" and "the overall context of this understanding" and "not to test whether data is generally valid" (Holme and Solvang, 1996, p. 15). However, reliability and validity of the results are important, and closely related to the sample size and knowing the limitation of the approach. The concept of saturation is often used to evaluate when the sample is sufficient. The saturation point is "when the researcher no longer receives information that adds to the theory that has been developed" (Malterud et al., 2016, p. 1758). As an alternative to the saturation concept of assessing the sample size, Malterud et al. (2016, p. 1754) propose the concept information power and how "the information power of the sample will be critical to achieve the aim, and the larger information power the sample holds, the lower N (number of units) is needed, and vice versa". "To offer sufficient information power, a less extensive sample is needed with participants holding characteristics that are highly specific for the study aim compared with a sample containing participants of sparse specificity" (Malterud et al., 2016, p. 1755). Seeking large information power, has therefore been the aim of the method. Regarding the limitations of the method, it is important to be aware that that the understanding from these interviewees cannot be generalized directly to the whole sector, as we cannot say how representative the understanding from the units within the sample is for all units (Holme and Solvang, 1996, p. 76).

Interviews

Qualitative interviews were assessed to be the best suited method for examining research question (1) on how analyses of urban freight transport can contribute to a more efficient city logistic, what type of data is needed

for the analyses, and how it could it be collected, as well as (2) what the barriers for the carriers to share this data with the public are, and how could these be overcome (see the research objectives in section 1.3). The choice was made as qualitative interviews are suitable for open-ended questions and in-depth discussions (Allen et al., 2012), which are useful to get a detailed picture of this issue. If there are questions that arise after collecting some data, this method makes it easier to make follow-up contact (Allen et al., 2012). Statements from the interviewees can also be followed up during the interview, to draw benefit from their knowledge and experience, as "qualitative methods want to capture what is special about the unit and their situation, and therefore what data is central in the research, largely depends on the data source" (Holme and Solvang, 1996, p. 78). In addition, it is easier to make clarifications during the interview, to make sure there are no misunderstandings. Qualitative interviews gives the opportunity to adapt the questions during the process, when it becomes more clear what questions are useful to ask after the initial interviews, as "qualitative research is characterized by flexibility", in contrast to "quantitative by structuring" (Holme and Solvang, 1996, p. 76). There is flexibility in terms of adding potential forgotten or rephrasing issues, and in terms of what questions and in what order they are asked (Holme and Solvang, 1996, p. 76 and 77). In this way, higher quality and more detailed information is obtained, compared to a survey (Allen et al., 2012), which would require more prior knowledge than current research provides, in order to have clear questions with pre-defined alternative answers. It enables more open questions in which the interviewees can give their expertise without "fitting it into a box", and going into depth on subjects the participants mention. However, it is important to keep in mind that using this method gives answers that reflects the perception the participants have of the reality. This therefore makes the sample selection important. The sample is described in paragraph 3.2.2.

Data analysis
As with the interviews, the knowledge sought from the data analysis, is exploratory rather than pre-defined. Going in depth on data sets from a selected number of carriers, enables closer contact with the carriers who can provide deeper descriptions of the aspects and possible usage of the data. The approach is investigative, making the number of data sets possible to analyze limited. The point is also not to get generalizable data, but to describe a subset of the current status with regards to data availability, content and structure.

3.2 Semi-structured interviews

3.2.1 Interview guides

The aim of the semi-structured interviews was to get the participants to do most the talking, based on an interview guide on the themes I was interested in. The purpose of the interview guide was not to be followed to the letter, but rather to include things to remember during the interview (Holme and Solvang, 1996, p. 96), as well as preparing the interviewees for the interviews (elaborated in section 3.2.3).

The **interview guide for the planners, researchers and policy makers** can be seen in appendix 6.2. The interviews gave insight into the participants' experience of working with urban freight transport and related challenges, specifically related to data, analysis needs and useful characteristics an analysis tool, as well as thoughts on the future organization of urban freight transport.

The interview started with the participants describing their experience of working with urban freight transport. This was partly to warm up, however, it also allowed seeing their answers in relation to their experience in order to be able to interpret the answers based on their conditions. This gives a more nuanced picture of the responses, and is in line with the importance of closeness to the participants, enabling valid data (Holme and Solvang, 1996, p. 89).

The planners were then asked about their experience of working with urban freight transport, and challenges, specifically related to data. This was to map whether the practical reality was in line with the research, or see if there were new aspects, and to see if there are any challenges standing out as the most critical.

Furthermore, their analysis needs, and whether they had issues that would be better solved with an analysis tool that is not currently available, was covered. This was to map what aspects of city planning could be improved

by access to data and an analysis tool, to identify the potential of collecting and having this data and tool.

Then, they were asked to describe a potential future analysis tool, in terms of what results could be needed, the level of detail, planning horizon, input and needed info/data for this. This was to get insights into what type of analysis tools is demanded, and seen in relation to the analysis needs.

Lastly, the future of urban freight transport was discussed. Trends affecting urban freight transport and the drivers behind them specifically. This was in order to get insights into how future analysis tools/models for urban fright should take into account the development/trends, or what will be most important to include etc.

The **interview guide for the carriers** can be seen in appendix 6.3. The interviews with the carriers gave insight into how what data they are willing to share, which requirements they have to the data processing for sharing it, and what concerns and benefits they see related to the data sharing. Furthermore, insights into what value they see in a common data access through a model was sought.

As described for the planners/researchers, warm up questions on their type of freight transport, their challenges related to traffic and planning of transport was discussed. This gave insights into the interviewees, and enabled seeing their responses in relation to this during and after the interviews.

They were then asked about urban freight data, specifically what data they use and how, what information they are and are not willing to share. This was to learn about the current data maturity, to see if there were variations, and what data that would not be accessible for an analysis tool/model. Furthermore, they were asked about the requirements they have for sharing data. This was to map what requirements I need to handle in the data analysis in this project, and what needs to be assured for future data collection and processing. They were also asked about the level of ease related to data extraction from their systems, in line indicating the data maturity.

In addition, a selected set of categories of urban freight data was presented. This was to specifically learn about the access to this data, and the format it would have. These can be seen in appendix 6.4.

The carriers were also asked about the value they saw in an urban freight transport model, and their potential usage of one. This was to investigate unlocking mechanisms for getting access to data in terms of making data sharing for this purpose meaningful and beneficial for them.

The carriers were also asked about their thought on future organization of urban freight transport, for the same reason as planners/researchers.

3.2.2 Samples

Figure 3.2 shows the sample. In total, 18 people were interviewed, in 15 interviews. 14 were conducted as individual interviews, and one as a group interview with four public planners. Trondheim was chosen as study area as contact with the freight sector in Trøndelag already was established with NTNU. The carriers were therefore connected to Trondheim, as well as the policy maker. Some of the planners had their experience from other parts of Norway, specifically Oslo/Østlandet. All had experience from cities in Norway.

Planners/researchers/policy makers

N (interviews)	N (interviewees)	Role	Sector	Called
4	4	Planner	Private	P-Pr
1	1	Researcher	Research institute	R
3	6	Planner	Public	P-Pu
1	1	Policy maker	Municipal	Pm
Total 9	12			

Carriers

N (interviews)	N (interviewees)	Sector	Called
2	2	Grocery	G
3	3	Thirds-party logistics provider	L
1	1	Construction	C
Total 6	6		

Figure 3.2: The two interview samples.

The planners and researcher had varied experience, with expertise mainly within urban planning, city logistics, logistics, socioeconomic analyses and traffic. Third-party logistics is "a term used to describe a company who owns and operates few if any trucks or other vehicles but focuses instead on supply chain integration and end to end services utilizing outsourcing of mainly truck operations" (Langeland et al., 2021, List of Terms) and these companies are denoted as logistics carriers in the following.

These do not cover all actors planning or researching urban freight transport, nor do the carriers cover the entire freight sector, e.g. service transport and renovation is not included. This is due to limited resources in the project, and what connections NTNU have. However, the interviewees represent different perspectives, and in this way give a picture of the complex actor situation and data needs, use and access. Furthermore, the carriers do represent different sectors, which could give a picture on the similarities and differences between data use and their relationship to their data. With regards to the chosen sectors and roles included, the aim has been to balance the time frame for the study while ensuring as good quality on the study as possible. The sample required for a narrow study aim for sufficient information power is smaller than a broad study aim (Malterud et al., 2016), and the study was therefore focused on selected sectors.

Holme and Solvang (1996, p. 95) states that as qualitative data collection is time consuming and demanding, the number of units that can be includes is limited, and around 20 units could give a rich data material. The selection of interviewees was done using purposive sampling. The selection of participants was done on the basis of strategy, choosing those that are most relevant, while also on the basis of variation, in order to capture a variation of experiences and perspectives. By ensuring a range of variation as large as possible, the information collected and gained is increased, as these have different experiences (Holme and Solvang, 1996, p. 99). The planners/researchers represent different experiences with and need for urban freight data and analyses, and the carriers represent different sectors.

Interviewees were recruited through different strategies. Some of the carriers were contacts of my supervisors from other freight projects, and others were obtained from conversations with people working with freight in the county. Some of the planners were suggested by my supervisors, and others suggested by interviewees and other people I had meetings with about my thesis. People were chosen based on expertise within the field. Several of the planners are within the most experienced of the city logistics field. To evaluate when the sufficient number of participants had been interviewed, the two concepts of saturation and information power was applied. The flexibility in qualitative interviews allowed evaluating on an ongoing basis whether more information was needed or information needed to be clarified, as analysis and data collection was overlapping (Holme and Solvang, 1996, p. 95). With regards to the concept of information power mentioned related to the quality of the study, interviewing experts within the field contributes to reducing the sample size needed. The saturation point was achieved quicker with regards to carriers than with the planners. This may have to do with the fact that not all sectors within urban freight were contacted, so the units were more similar than the planners/researchers. The contacted carriers' experience with urban freight data were more similar than among

the planners/researchers, and thus the answers more alike.

3.2.3 Executing the interviews

Before starting the data collection, the study was approved by the Norwegian Centre for Research Data (NSD), who gave permission for audio recording. Appendix 6.5 and 6.6 shows the information given to the participants when asking for their consent, including on privacy handling and that it was voluntary to participate. This document is based on the template on NSD's web page.

Before the interviews, the interviewees were invited to an information meeting where the project plan (introduction, purpose, research questions and state of the art) was presented. The purpose of these meetings was to identify the perspective of the interviewees, in order to prepare the interviews better, as when interesting and significant matters are clarified, "one is able to ask more fruitful questions" (Holme and Solvang, 1996, p. 91), as well as for the interviewees to be better prepared. The meetings revealed that the planners/researchers have a different perspective from the carriers with regards to urban freight transport data, as the carriers have access to that data themselves. Furthermore, the information meetings revealed that the concept "urban freight transport model" was not the right to use in relation to the planners/researchers. When the word "model" was used in terms of what data they needed for a model, their responses focused on what specifications the model in question had, as that would determine the data need. Therefore, the questions and project purpose for the planners/researchers were reformulated to ask about the analytical work they are doing or would like to do in order to improve urban freight transport planning. The information meeting and preparations for the interviews also contributed to the data validity (Holme and Solvang, 1996, p. 89), by ensuring I knew the context and situation of the participants.

The first draft of the interview guides was reviewed by professor Tørset and Pitera (the study's supervisors) and adapted based on that. Some days before the interviews, the participants were sent a reiteration of the purpose of the study and the interview guide. This allowed them to prepare some thoughts to these questions/themes, stay on the subjects and contribute to the intended outcomes. According to Holme and Solvang (1996, p. 89), the researcher has to be conscious about the extent to which they take an active or passive role in the interview situation in order to obtain the most valid data. The researcher should act in a way that makes the outcome of the interviews to the greatest possible extent is the interview objects' own, and "this will in most cases best be achieved by taking the role of the interested listener" (Holme and Solvang, 1996, p. 92). Providing information in the invitation, having information meetings and providing the questions beforehand ensured a good dialogue which is important for the sample size and information power of the interviews, as "information power is also related to the quality of the interview dialogue. A study with strong and clear communication between researcher and participants requires fewer participants to offer sufficient information power than a study with ambiguous or unfocused dialogues" (Malterud et al., 2016, p. 1755).

Primarily, individual interviews were used. In one case among the planners, however, using a group interview was convenient. A group interview allowed these interviewees, with different perspectives on the subject, to build on each others' input to formulate what they thought about the case, as group interviews create "discussions between people that in social interaction with like-minded develop and form meanings and attitudes" (Holme and Solvang, 1996, p. 103). The group consisted of people who knew each other, so they knew what their role and contribution to the interview was, reducing the risk of the minority point of view being oppressed in group interviews (Holme and Solvang, 1996, p. 103). Individual interview was chosen as appropriate for all carriers due to competitiveness.

The interviews with planners ranged from 24-48 min, and carriers from 1h to 2h. The interviews were conducted from February to April 2021, the majority in March. They were digital over Teams due to the ongoing Covid-19 pandemic and the travel restrictions and encouragement to limit social interaction. Conducting the interviews online was an advantage in the way that it was easier to find times when the participants were available. This made it possible to contact people in different areas without travelling, thus reducing the use of resources in terms of time and money.

3.2.4 Analyzing the interview data

The transcriptions of the interviews were done shortly after, with the interviews fresh in mind. During the transcribing, reflections were noted in a separate document. These reflections developed from important things said in one interview, to reflections of what was said in one interview in context of that said in others. In line with the privacy handling approved by NSD, all information on the interviewees that could link them to their company or personal information was excluded from the transcripts. Transcribing all the interviews was time consuming, but contributed to the quality of the study, as it allowed reflecting on the interview in whole, and made it easier to understand and remember for all involved parties. The transcripts were sent for approval and potential correction to the participants. Giving the participants the possibility to read through their responses, enables them to assess whether my interpretation covered what he or she meant to communicate (Holme and Solvang, 1996, p. 102). Several of the participants made comments to the transcripts, e.g. elaborating or clarifying things that came out wrong, so giving them the chance to read through, and they taking their time to do so, contributed to increasing the quality of the data. In several of the interviews there were words or paragraphs that were unclear to me as I transcribed, so this was marked in yellow for the respective to clarify. The recordings were deleted as soon as the interviewees approved the transcript.

Due to the format of qualitative data, the analysis is time demanding, and in contrast to analysis of quantitative data, structuring and organizing have to be done after data is collected (Holme and Solvang, 1996, p. 131). However, the interviews had main topics, as defined in the interview guides (see subsections 3.2.1 and appendix 6.2 and 6.3). The program NVivo was used for the analysis. The transcripts were imported to the program, and the transcripts then red through and sorted in a set of categories, by the "coding"-function in Nvivo.

The categories used to sort the findings from the interviews are shown in figure 3.3 and 3.4 below. I coded the interview guides first, then added some codes based on answers; searching for a balance in having enough codes, but not so many that relationships are missed. The files-column indicate in how many of the transcribed interviews the code was found, and the references the number of times the code was used marking a section of the documents.

Name	Files	References
P-About the method	1	1
P-Description of analysis tool	7	27
P-Planning horizon	3	3
P-Results wanted	4	7
P-Spatial resolution	3	7
P-Time resolution	3	5
P-Vehicle resolution	1	3
P-Experience with UFT	9	99
P-Challenges with working with UFT	9	76
P-Consequenses of the lack of analysis tools	8	13
P-Data related challenges	8	35
P-Lack of analytic tools for city logistics	6	15
P-Working with UFT today	9	23
P-Future urban freight transport	8	33
P-Drivers	1	1
P-Future organization of UFT	8	31
P-Autonomy	3	3
P-Demands about data sharing	1	1
P-Need for analysis tool	9	67
P-Data need for the analysis tool	7	24
P-Numerous actors	1	1
P-Relationship with other freight models	4	5
P-Transporter involvement	6	16

Figure 3.3: The codes used for processing the interviews with planners/researchers/policy makers.

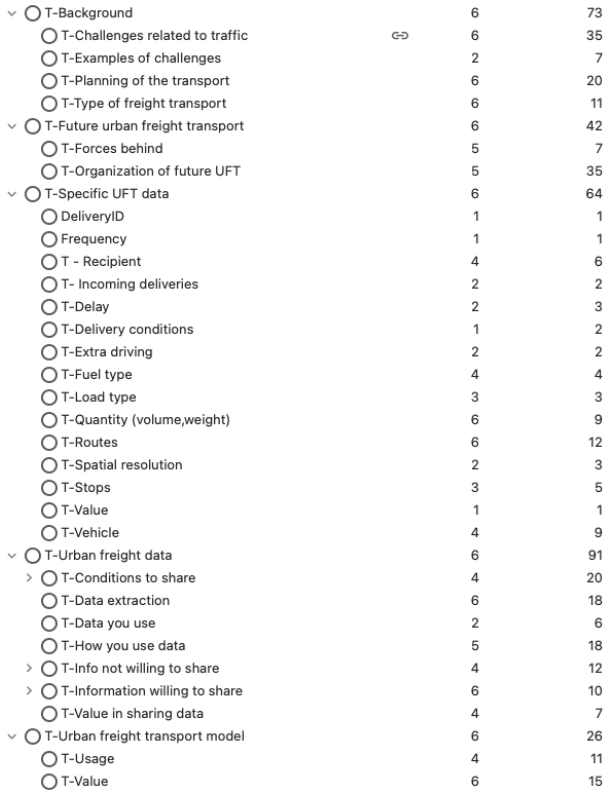

Figure 3.4: The codes used for processing the interviews with carriers.

The planners/researchers/policy maker and carriers operate on different levels and have different needs with regards to data, which was reflected in their answers. The answers of the first group were more strategic and varied, and cross-sectional analysis not suited. The point was not to compare their needs, but rather get the "whole" picture, and see how to best meet this. For carriers, their focus was more operational/practical, and comparing more relevant.

To show the interviewees' way of expressing themselves, direct citations have been included, both for documenting the understanding I present, and convey the results in a more exciting way (Holme and Solvang, 1996, p. 88 & p. 136).

3.3 Analysis of example freight delivery data sets

The second part of the study is analyses of delivery data sets, with the purpose of researching a method to extract data from delivery data sets, including to obtain insight of methods to automatically identify and correct faulty reports, double reports and deficient reports. The comparison of the data sets gave an indication of the standardization of this kind of data, and thus on how general the use of data can be. The purpose of the data analysis is to provide knowledge for further research going to collect urban freight delivery data from carriers.

Acquiring the data

Delivery data sets were obtained from the same carriers as were interviewed. This was sought because of the link between these two perspectives on getting data from companies, by getting insights into their concerns and requirements for providing data, and trying to solve and meet these concerns and requirements. When the companies were asked to participate in the interviews, they were asked if they were willing to share data sets. During the information meeting, what data that would be valuable for the study was discussed. Based on this, data sets were acquired.

The data sets were specified to not having to be representative or over a long period of time, e.g. a week would work. The format is what has been investigated.

About the data

Secondary data, as it is collected by the carriers, is used in the analysis. The spreadsheets include raw data, i.e. data that is not yet summarized, one row rather describes one thing, in this case a delivery. Raw data was sought to be obtained, as it enables more flexibility with regards to analyzing it, as well as evaluating the integrity and quality of it (SAGE Publications, 2017).

It is assumed that the data obtained is representative of the rest of the carriers' data, except where I know the carriers edited the data to adjust it by e.g. including vehicle type. In any case, it is known to be possible to obtain this data, as the carriers were able to give it for this project. The data is not representative, but the format is assumed to be.

Describing the data obtained:

- Six delivery data sets were obtained, with the same sample as the carriers. I.e. two data sets from grocery carriers, one from construction carrier and three from third-party logistics actors.
- The delivery data covers deliveries in Trondheim from the carriers, and specifically the "last mile".
- All data sets except for one were in the form of Excel spreadsheets, which was given as a txt.-file and converted to Excel.
- All of the data sets have different formats. The content is different, and the headings for the columns including the same information also varies.
- The logistics carrier delivery data is from their B2B (business to business) segment.

Data processing

First, the data was run through in Excel, using filtering of the columns to get an understanding of the content, and whether it was standardized etc. With the limited number of data sets and amount of data within them it was possible examine the data in detail and get a thorough understanding of it.

The delivery data was analyzed to research the similarities and differences between the data from the different sectors/actors, to see if there are any trends etc. Furthermore, the analysis aimed at investigating how the data match with the data that is required based on the State of the Art and interviews with the planners/researchers/policy makers. This include what information that can be gained from the data, related to their type, format and scope, and what other data sources/data that would be needed for the information that the delivery data potentially does not provide. Furthermore, how data can be collected automatically from the data sets is looked into. The data sets were handled in line with the requirements set from the carriers.

Extracting data from these data sets would be the next step, and then collecting the data from the different data sets in a joined database.

4 Results and discussion

The research questions will be discussed based on the empirical results. In order to strive for validity of the results, the findings are discussed in light of the existing literature (Jacobsen, 2005). The interviews and data analysis have given a range of findings. Some of these findings confirmed the state of the art, whereas other uncovered new aspects. Whilst confirming the state of the art is important, this section will focus in particular on the aspects that were new. The direct findings from the interviews are presented in more detail in appendix 6.8 and 6.9, and the findings from the data analysis in section 6.10. The abbreviations used in the results in the appendix are included in appendix 6.7.

Figure 4.1 summarizes the main findings on obtaining carrier data and the potential it gives from the study, and shows the relationships between them. A set of requirements for sharing data has been identified from the interviews with the carriers. These requirements make them willing to share data on a large scale. From the obtained delivery data analyzed in the study, a range of information could be extracted. The figure shows the total amount of information, no data set included all of this information. However, it means that all of this information is possible to gain from current delivery data sets. This data provides a range of insights that could be gained by collecting the delivery data, if complying with the carrier terms, within a common database. From an analysis tool enabling these insights, a range of benefits related to freight data and modeling have been identified. The benefits are both a result of the data sharing, and a prerequisite for the data sharing, in turn enabling the benefits to be released. The figure therefore also shows the revealed relationship between these aspects: the data sharing requirements enables data sharing, which then again enables insights, providing benefits, which again can enable new data and new insights etc.

Figure 4.1 is based on the empirical approach, which includes selected carriers and delivery data. The conditions could probably apply to other data and other carriers, and the insights probably come from other freight data as well, in any case not from delivery data alone, as the data analysis have illustrated. The delivery data has to be used together with e.g. network data and assumptions, to give these insights and benefits, enabling this relationship.

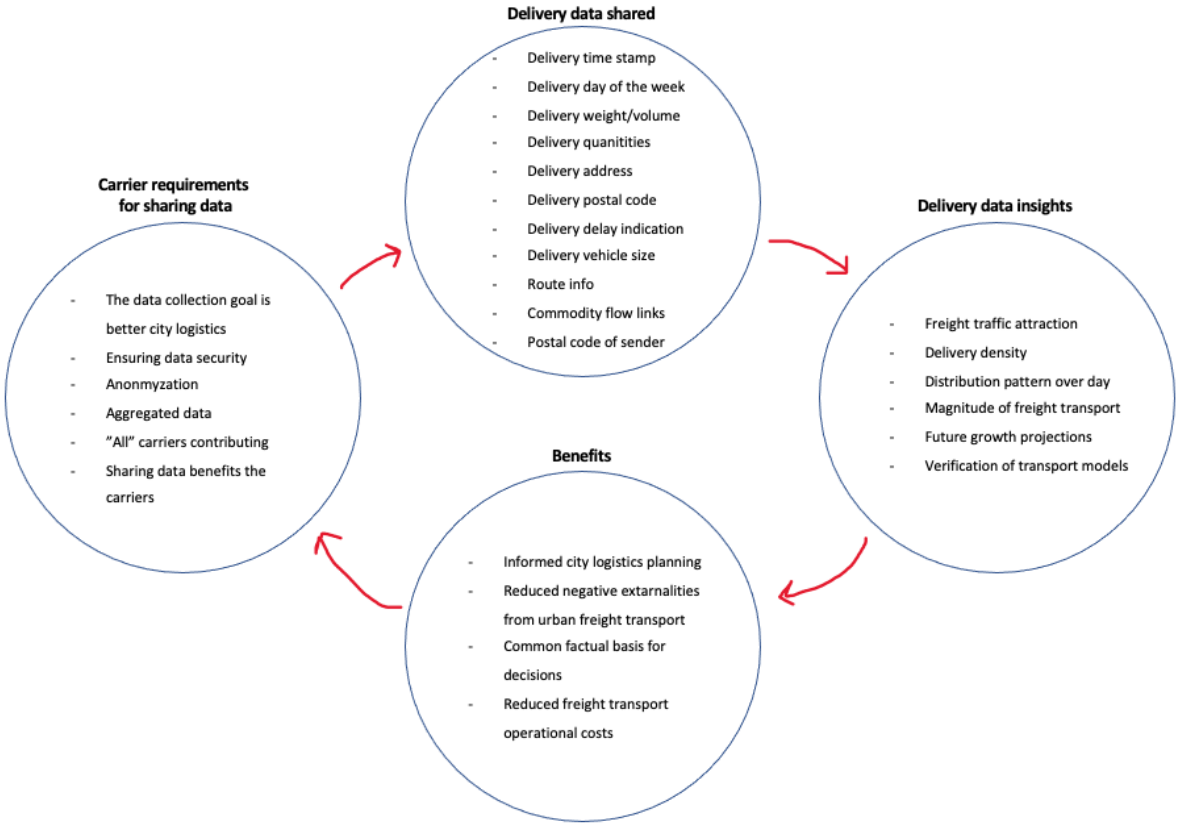

Figure 4.1: The figure shows the conditions for sharing data from the respondent carriers, the information in the data shared by them, the potential insights this information could give, as well as the benefits these insights could provide, and the relationship between the aspects.

The benefits aspects will be elaborated in the discussion of the first research question (subsection 4.1), the requirements for sharing data in the discussion of research question 3 (subsection 4.3), the obtained data and insights from it in the discussion of research question 4 (subsection 4.4) and how a tool could enable this relationship in the discussion of research question 2 (subsection 4.2).

The term "analysis tool(s)" is used and discussed during the interviews. As described in the research objectives, this refers to a tool that meets the analytical needs of planning towards more sustainable urban freight transport. Access to analysis tools is seen as a subset of analytics. "More sustainable" is defined as more efficient in terms of operational cost, i.e. an economic aspect, more accessible for all in terms of equity, i.e. a social aspect, and with less carbon footprint, pollution, being more environmentally and climate friendly, i.e. an environmental aspect. Planning is in this study generally interpreted as the activities required to achieve certain goals and strategies. In the context of planning the infrastructure/land use in urban areas, the goal formulated for most cities is to be attractive and sustainable cities. For the carriers planning entails planning their transport operations to achieve their goals, e.g. on efficiency and reliability.

4.1 What are the potential benefits of urban freight transport analysis for more sustainable city logistics?

The interviews with planners, the researcher and the policy maker and the carriers are used to address this first research question, which is addressed to identify motivation for developing and contributing to an urban freight transport analysis tool.

4.1.1 The need for analyses

The results from the interviews with planners highlighted a range of needs related to how analyses would improve their work within urban freight transport. These needs indicate how improved data collection to an analysis tool could benefit these actors. The needs can be categorized in three groups related to:

- **Obtaining a holistic picture**
  - The public planners want better exploitation of existing capacity in urban freight vehicles.
  - The public planners also want to reduce freight transport need and traffic to avoid freight transport using capacity released as a result of the zero-growth goal.
- **Obtaining knowledge based on numbers**
  - The policy maker wants agreement on the factual basis for policies.
  - The planners want to be able to say something about today's situation.
  - The public planners want to have control of and further estimation of NGM and RTM.
  - The private planners want control of actual volume of freight transport in order to do socio-economic analyses, to quantify the benefits for freight transport.
  - The public planners want better prognosis of the transport on the road network to use in cost-benefit analyses.
- **Obtaining knowledge on the effect of measures**
  - The planners want to see the effect of measures.
  - The policy maker wants to take decisions on whether to scale up or not to implement measures based on evaluation of them.
  - The public planners want to communicate the benefits or evaluation criterion to make ideas interesting for private actors.

Overall, these are the important thing for an analysis tool to enable, in order to give value to the groups interviewed. As we see, the different groups within the sample have different views, related to their role in the city logistics. Identifying the needs of each group, and ensuring that all groups' needs are met by an analysis tool, will give more engagement and ensure uptake by several user groups.

In general, the interviews showed that current lack of data and analysis methods of urban freight transport leads to the planners and researcher using qualitative approaches when working with urban freight transport. The planners expressed that as they cannot quantify potential benefits of new measures, they have to describe them in words; and they can only express how they imagine it will be, often with difficulty and based on a lot of uncertainty. In the socio-economic analyses they often use static shares of heavy vehicles. Simultaneously, identifying potential negative consequences is also difficult. As part of the qualitative approach, is the need for using involvement and dialogue with the carriers. All of the interviewed groups paint a picture of the current situation whereby urban freight transport actors is involved after many of the decisions on infrastructure are taken. As a contrast, involvement of the carriers in time for them to give input and views on ongoing processes would create trust and good solutions, and is pointed out as an essential success factor for good city logistics. The current involvement of carriers is therefore beneficial, but the current practice has potential for improvement.

One of the private planners remarked that in the consulting industry they have a limited budget, "so the level we have set ourselves here is qualitative assessment based on experience and local knowledge" [1], illustrating that budget constraints, and lack of data and efficient tools/methods for quantifying effects lead to decisions

[1] "så er det litt sånn i rådgiverbransjen at man har begrenset budsjett, så nivået vi har lagt oss på her er kvalitativ vurdering basert på erfaring og lokalkunnskap"

being made without a data-driven understanding of the situation. The planner continued to describe how the result of the projects therefore "is what you think is best, within the framework that you have" [2].

4.1.2 Benefits from analysis

The results from the interviewed **planners** showed that being able to plan the city/infrastructure based on more knowledge of the traffic/freight situation, accurate data and less assumptions, enable them to provide better access to goods for the inhabitants by making better use of infrastructure/area in the crowded city centre, reducing the negative external impacts and operational costs of the freight operators in the city. The carriers interviewed also expressed how a more attractive city is valuable for them, reflecting this.

The **policy maker** interviewed indicated that the ability to make decisions reflecting the actual freight traffic situation, on a quantitative basis that can be "proved" has the potential to reduce political disagreements.

Both the public planners and policy makers interviewed are interested in a way of gaining interest from private actors to innovate in city logistics. An analysis tool should therefore be able to demonstrate benefits for private actors in order to benefit them, and contribute to more sustainable city logistics.

Some of the needs expressed by the planners in the public and private sector, the researcher and the policy maker are aligned, others vary. In general, the same knowledge will provide them with different opportunities. Enabling value to all of these, will be important in order for an analysis tool to be the most efficient.

However, the planners and researcher expressed that data and knowledge on the current situation is the most critical to sort out first, and will be the basis for knowing what long-term tool to develop.

The **carriers** also mentioned aspects of an urban freight transport model which would be valuable for them:

Increased focus on urban freight transport and interaction (samhandling) between public authorities and the various carriers: During the interviews, valuable implications of an analysis tool for the carriers was increased attention and focus on the problems within urban freight, as well as enabling interaction between the public authorities and the various carriers. A logistics carrier described the current situation as: "there isn't really good collaboration with e.g. Trondheim municipality and us in relation to this. We have expressed our wants and needs, but there are no forums for cooperation. When working with data models, simulating traffic into cities, when deliveries arrive etc., then the aim should be to create interaction between the public authorities and the various carriers" [3]. This shows that a condition for the carriers benefitting is that the tool is developed with a clear purpose and something that the authorities will use, showing the importance of developing the right tool. A carrier pointed out that such a model should enable cooperation both among the carriers and between the carriers and the municipalities. This benefit for the carriers, is therefore contributing to giving value to the chain. However, potential cooperation between carriers has to be in line with the regulations for competition.

More efficient distribution from information enabling better planning of their own transport: The interviews revealed that the carriers have no statistics or numbers that show when there is high pressure on the delivery areas in different areas, but rather have to base this on feedback from the drivers. One of the carriers expressed how: "now we do know of some particular places where we need to be at a specific point in time, or within a time window, because of traffic challenges or parked cars etc. But we don't have this information overall" [4], while having it structured and holistic in a model "could perhaps give us some good indicators, so we can plan more efficiently" [5]. Logistics and grocery carriers also mentioned that there would be value in seeing the capacity different places in the city as the demand for the area and loading/unloading zones, as one of the logistics carriers wanted to have knowledge on: "does, for example, the curve go drastically up at Solsiden

[2] "blir hva man tror er best innenfor de rammene man har"

[3] "per i dag er det ikke noe godt samarbeid mellom Trondheim kommune, f.eks., og oss, knyttet til det der. Vi har kommet med våre ønsker og hva vi vil ha, men det er ikke noe samarbeidsfora. Når man jobber med datamodeller og skal simulere trafikk inn til byer, når det leveres osv., så må jo målet være å få til samhandling mellom offentlige myndigheter og de ulike transportørene."

[4] "Nå vet vi om noen steder vi må være til det og det tidspunktet eller innenfor det tidsrommet pga. trafikale utfordringer eller parkerte biler osv. Men har ikke slik informasjon i det store og det hele"

[5] "kan kanskje gi oss gode indikatorer på det. Da kan vi kanskje planlegge mer effektivt"

between 9 and 11?" [6], as they have expectations of. This could be valuable for them, in terms of enabling operational planning based on when they see that the capacity is better. In spite of having relatively rigidly planned routes (see subsection 4.5.1 on the planning), a grocery carrier says that "we have the possibility to juggle the order, if its known that a route will be stuck 45 minutes in a queue because of a known problem" [7]. This shows that the carriers can benefit in terms of more efficient operation if they get this kind of results from a tool.

Summarized, the interviews identified that the carriers see potential for better planning for of their own distribution if they have access to a tool that enables them to:

- See trends for when the demand is high, when loading areas are full, in terms of statistics on addresses or areas (separating between loading zones/construction sites). This would enable them to plan tactical based on that information, i.e. changing the time window for customers to remove deliveries in the most hectic period, juggling the route/order or spread deliveries throughout the day. The carriers believe that this could lead to more efficient distribution, meaning less kilometres driven and waiting time spent, saving operational costs, and reducing environmental impacts.
- See what volumes the others are transporting through the city, in order to align (samkjøre) transport. This could lead to more efficient distribution, and less vehicles, also reducing operational costs and environmental impacts.

At the same time, carriers also expressed a level of uncertainty on the benefits of modeling and analysis. Not all of the carriers are sure whether the model would be useful for them directly. One pointed out how their plans from day to day are quite rigid, which "(...) they have to be, to make the routes efficient" [8]. However, by having a holistic view, the carriers could rather benefit by adapting their more tactical/strategic plans. A carrier summed it up as: "I think this would have value because one'd get a holistic picture, but I don't quite see how we would use it in practice and operationally" [9]. A grocery carrier stated how: "the value on our part of working on this I think is limited, I think the most value is related to being allowed to contribute to planning, to be part of a strategy that say a municipality facilitates" [10]. This is related to their deliveries: "The deliveries are in many ways directed by other factors than what we can plan, such as when the shop wish to receive the goods" [11]. Another carrier also don't see it as useful for their operation: "I don't really see value for our own business. Because even if the data from the large actors are collected, you would not capture the data from the small actors, who also are many" [12]. This shows that there are different views on the benefits from a tool for the planing of the carriers' transport within the field, and research on these views would be useful in order to persuade the carriers. There seems to be an indication that the more flexible the plans of the carriers are, the more positive they are to how this information could contribute to more efficient operations for them. A few of the carriers expressed that they are most concerned with themselves and meeting their customers' satisfaction from day to day, illustrating the importance of contributing to a tool requiring little resources from the companies.

Regarding the benefits of modeling and analysis, the carriers are also concerned with how the tool would be used by the planners/authorities. A carrier explained how: "I'm a bit uncertain as to what value this will have for others, apart from the researcher who does research on this? (...) If it is not used for better planning I'm uncertain as to whether it is useful" [13]. This illustrates the importance of developing a tool that meets the

[6] "går det f.eks. en kurve voldsomt opp på Solsiden mellom 9 og 11?"

[7] "vi har mulighet til å sjonglere litt på rekkefølgen, hvis man vet at en rute blir stående 45 min i kø på grunn av en kjent problemstilling"

[8] "våre ruter rimelig faste, og det må de også være, for å få effektivitet i rutene"

[9] "jeg tenker at dette hadde hatt en verdi fordi man fikk et helhetsbilde, men jeg ser ikke helt hvordan vi skulle brukt det praktisk og operativt"

[10] "verdien for vår egen del med å jobbe i det her tror jeg er begrenset, jeg tror den største verdien er knyttet til at man får være med som bidragsyter inn mot planlegging og være et moment i en strategi, som kommunene eller noen legger til rette for"

[11] "Leveransene er på mange måter ofte styrt av andre premisser enn det vi kan planlegge, som når det er butikken ønsker varene"

[12] "Ser i utgangspunktet ikke verdi for egen drift. Fordi at selv om dataen fra de store aktørene samles, vil du ikke fange opp dataen fra de små aktørene, som også er mange"

[13] "jeg er litt usikker på hvilken verdi det har for andre, utenom den forskeren som forsker på det? (...) Hvis det ikke blir brukt

needs of the actors involved, so they will use it, and it can give the desired implications.

Seeing the benefits in relation to each other

Both the carriers and planners highlight the importance of predictability for the carriers in urban freight transport. Contributing to increased predictability would be important in order to provide benefits for them. By the planning being based on the actual volumes in the city, it is less likely that sudden measures reducing the competitiveness of urban freight transport can be implemented. Better knowledge of the freight situation in the city for the planners and for the carriers, will therefore improve the predictability in the form of less unforeseen time-consuming events, such as looking for loading/unloading zones and new traffic regulations.

The goals are therefore aligned to a large degree. The literature has showed how common ground between the varied perspectives is an important precondition for collaborations to succeed (Kijewska et al. (2016); Allen and Browne (2016); (London Data Commision, 2020)). Another finding was how when the analysis can help carriers see benefits, or create innovation, the municipality benefits. This is therefore a common goal of a tool.

The literature and results show how knowledge based on high quality data giving a common factual basis, can improve cooperation between actors within freight planning, as it reflects the situation of the carriers. The carriers' feeling of the authorities "forgetting" that the freight has to be solved, and the planners' experience that the urban freight is given a thought only after all other aspects in the city planning have been considered, will give the planners a "reason" not to avoid it, since they now have knowledge to solve it well.

The following figure 4.2 shows potential benefits from an urban freight analysis tools for planners/researchers, carriers and public authorities/policy makers. The actual reach of benefits will depend on the characteristics, data and purpose of a tool. This illustrates how these different actors involved in freight would benefit. In order to address adequate and efficient city logistics measures in the complex stakeholder landscape of city logistics with conflicting goals and the confidentiality of information; trust, commitment and a clear understanding of stakeholder behaviour is necessary (Lepori et al. (2010); Neghabadi et al. (2019)). The figure shows how the different actors each gain benefits, and that many of the benefits are common, indicating how cooperation will create mutual benefits, as well as provide an overview of the different actors, to give them a better understanding of the others.

til bedre planlegging, er jeg usikker på hva nytten i det er"

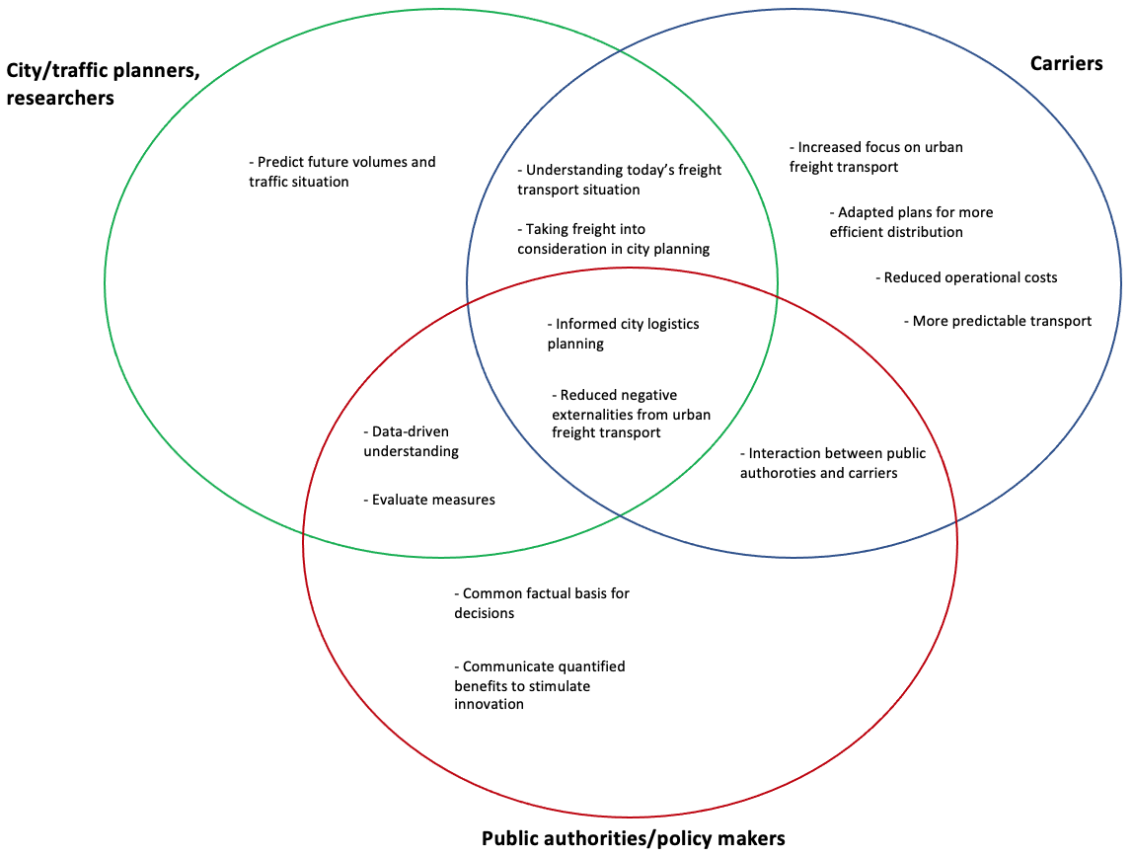

Figure 4.2: Potential benefits from an urban freight analysis tool for planners/researchers, carriers and policy makers/public authorities. The realization of the benefits will depend on the characteristics and purpose of the tool.

A future urban freight transport analysis tool seem to have potential to improve planning for both the planners and carriers. However, as the carriers have established routes and zones they drive, re-planning these, even if it potentially improves their efficiency, can meet resistance, and be difficult to implement. As the drivers' knowledge to a large degree is used for the planning, a robust data basis from the carriers that reflects their actual challenges and knowledge should be in the carriers' interest, in order for them to benefit. The carriers do not seem to think they will use the outputs from an analysis tool practically from day to day, but rather to see trends/gain a holistic view, related to the rigidness of their plans and potential for adapting them. Meanwhile, their most important motivation is to contribute with inputs to a robust tool, to avoid planning and decisions that complicate their work as a result of lack of knowledge within the public sector about the urban freight sector and transport. All actors see the tool as a way to reduce negative externalities associated with urban freight transport.

4.2 What is required to improve current freight transport analysis?

The second research question is also addressed based on the results from the interviews with the planners/researcher/policy maker and carriers, with the purpose of exploring what aspects a tool releasing the potential benefits would have.

4.2.1 Purpose of an analysis tool

Regardless of how an analysis tool seem to propose aligned goals, it is worth spending time considering what an urban freight analysis tool should give answers to, based on the current challenges of freight analysis and distribution. This will affect the data need and characteristics of a tool. The planners mentioned a range of

needs, and the carriers a range of challenges indicating measures to evaluate, which perhaps do not all fit into one tool, and perhaps not all are suited for a modelling tool. Some of the planners mentioned lack of knowledge on traffic load and route choices. To have accurate data on this, tracking data would be needed, but in the lack of tracking data, estimations could be used, based on assumptions on the route choices. If this is the main purpose, it is most important to have quality/accurate data on the commodity flows, the start and end and stops of the deliveries. If the main desired output/insights from a tool is the scope (omfang) of transported goods, it is more important to have data on the volumes and/or weight and type of goods. Furthermore, if the most important purpose is e.g. to gain insights into emissions, climate gases and local pollution; accurate data on the vehicle fleet is more important, in addition to good estimations, or preferably data, on the kilometres driven and the weight/load. So, some of the purposes will require more or less data, and regardless, the purpose will affect what data should be collected. Furthermore, the purpose will also affect the detail level needed, both with regards to the detail level of data needed, and the detail level of the calculations

The purpose the tool is developed for, will therefore be an important factor in how a tool will lead to potential benefits. The results from the interviews with planners/researchers/policy makers, revealed that the purpose of an analysis tool should be to identify and convey economic benefits/commercial interests; provide a common factual basis; and provide new knowledge, as further described below.

Identify and convey economic benefits/commercial interests

Related to the effect of measures, the policy maker was interested in using the information to **know which measures to scale up** or not to implement, and in line with the public planners, to **communicate benefits to create innovation**. The policy maker in the municipality expressed a wish to create innovation, pointing out their role for facilitating good solutions. The public planner in the municipality expressed the same, as what is most useful for them to know is: "what make the actors interested in investing in testing out a new measure. For example whether a measure can be linked to financial gain" [14]. They stated that this is related to how the municipality cannot promise any economic benefit, and rather the market is responsible for that. Another public planner states the same: "we have to find the sustainability in this amongst the businesses themselves" [15]. A private planner is concerned with the same: "if everyone does as the authorities say, that's fine, but there will always be the economy of the individual businesses that accelerate or hamper a development. So, when businesses find financial opportunities that coincides with the environmental requirements such as climate emissions, then the pace speeds up" [16].

In order to identify and convey economic benefits for the carriers, the ability to quantify carrier cost/benefit is needed. This is in line with what a private planner expressed: "the choices made by carriers are often made based on cost. (...) In the long run, within limits, they implement the solutions that are the most effective" [17]. A public planner says: "the challenge is not ideas, but to realize these. And realizing by the actors is governed by the market – economic benefit. It is not always easy to make an actor try something new; it is not easy to make them interested. If the actor see self-interest, they will invest and complete it" [18]. This highlights the importance of identifying and ensuring the value for the carriers.

A public planner mentioned how the regulating authority, the municipalities/counties, have to be involved in the solutions, on both operational and strategic level in order to create good solutions, and this can be helped by them benefitting from using an analysis tool, i.e. by stimulating innovation among the business community (næringslivet).

Provide a common factual basis

[14] "hva som gjør aktørene interessert i å satse på å teste ut et nytt tiltak, f.eks. om et tiltak kan kobles til økonomisk gevinst"

[15] "vi må finne bærekraften i det hos næringslivet selv"

[16] "Hvis alle gjør som myndigheten sier, er det greit, men det vil alltid være økonomien for den enkelte bedrift som vil akselerere eller hindre en utvikling. Slik at når bedriftene finner økonomiske muligheter som sammenfaller med kravene til miljø og bl.a. klimautslipp, da blir det tempo på saken"

[17] "valget til transportører og lignende ofte er styrt av kostnader. (...) I det lange løp, innenfor begrensningene, legger de opp til løsninger som er mest mulig effektive"

[18] "Utfordringen er ikke ideer, men realisering av disse. Og realisering hos aktørene styres av markedet - økonomi og nytte. Det er ikke alltid lett å få en aktør til å prøve noe nytt, da det ikke er lett å gjøre aktøren interessert. Om aktøren ser sin egen nytte, da vil de investere og gjøre det ferdig"

For the policy maker, in addition to engaging private actors, a common factual basis for decisions was stated as valuable. With regards to the common basis, they stated that: "what we try to obtain by dialogue and involvement (...) it's with the view of obtaining a common factual base that we can present to the politicians, so that we can agree what the policy is built on. Then one may well make different political choices, but the more one manage to agree on the factual basis, the better" [19]. This includes factual basis for decisions on whether to scale up or down measures, as it was expressed to help reduce the conflicts within urban freight planning and actors. A valuable factual basis was also mentioned by the private planners, expressed by one as: "I think it could be useful through the planning work, to enlighten the decision makers, which for the street use plan is politicians, on how large volumes we are talking about, this would make it more tangible" [20]. By being able to quantify the volumes, it can be treated accordingly.

Provide new knowledge

By being able to analyze urban freight transport, new knowledge on how to exploit the capacity can be created, as well as ways to reduce the transport. This is correlated to the point about innovation, as the new knowledge can contribute to creating innovation.

This is related to the zero-growth goal, about which the planner in the municipality expressed that: "prognosis shows that freight traffic in cities is increasing a lot. The municipality is interested in reducing the need for driving and the length of driving for freight traffic, in order to avoid the impact of restrictions on car use being outweighed by increased freight traffic" [21]. This highlights an urgency for efficient urban freight solutions before the negative consequences increase.

New knowledge that the planners also mentioned is needed, is related to the expected growth in urban freight volumes. Quantifying the situation today, is further pointed out as needed to quantify prognosis. As expressed by the planner: "we know that the extent of urban freight traffic will increase, but not by how much, and where it will increase the most. Where in the centre will we see the highest density of driving, dwell times etc.? This is about planning for the future. It is important to have a quantitative starting point for the planning; numbers tell a lot. Then it's not just subjective considerations from each professional" [22]. This reflects how the current approaches of qualitative analyses do not qualify to predict the future volumes. It also demonstrates the planners' need for the ability to quantify the current urban freight volumes, especially with regards to the expected increase in battle for space with more urbanization, population growth and freight transport demand, as well as how the authorities will have to deal with the problem when they have the knowledge to solve it.

4.2.2 Characteristics of a tool

The planners interviewed mentioned a range of relevant measures with the aim of improving the situation for urban freight deliveries. As the planners highlight the need for an analysis tool to enable evaluating measures, a thorough picture on what measures are relevant, is essential in order to develop a tool that adds value to the freight chain. The measures that would benefit from an analysis tool mentioned by the planners during the interviews are:

- Toll rings (bom) - change in location and fee.
- Rerouting of passenger traffic.
- Night time deliveries.

[19] "Det er det vi forsøker å oppnå med god dialog og involvering (...), det er litt med tanke på å få et felles faktagrunnlag som kan legges frem til politikerne, sånn at vi er enige om hva politikken bygger på. Så kan man gjerne ta ulike politiske valg, men i den grad man klarer å bli enige om et faktagrunnlag, jo bedre er det"

[20] "Jeg tror det kunne vært nyttig å gjennom planarbeid opplyse beslutningstakerne, som for gatebruksplanen er politikerne, om hvor store volum det faktisk er, og at det blir litt mer håndgripelig"

[21] "Prognoser om næringstrafikk i bymiljø viser stor økning. Kommunen er interessert å redusere kjørebehov og kjørelengder for næringstrafikk, for å unngå at effekt av bilrestriktive tiltak (= frigjort kapasitet) brukes opp av økt næringstrafikk"

[22] "Vi vet at det omfanget av godstransport i by vil øke, men ikke hvor mye det vil øke, eller hvor det vil øke mest. Hvor i sentrum er det tettheten vil bli høyest av kjøring, oppholdstider osv.? Det handler litt om å planlegge ut fra framtidsperspektivet og. Det er viktig å ha litt kvantitativt utgangspunkt for planleggingen, tall sier mye. Da blir det ikke bare en subjektiv vurdering av hver enkelt fagperson"

- Consolidation terminals.
- City terminals.
- Development of different areas (land use).

As described, the measures that must be possible to evaluate, should be in line with the purpose of the tool, and vice versa, as this affects the characteristics the tool.

The results desired from an analysis tool also affects the characteristics of a tool, and should therefore be in line with its purpose. This contributes to providing info on how a tool should be developed for it to be valuable, and also relates to the measures that are desired to evaluate and analyze. The interviews with the public and private planners revealed that the desired results from an urban freight transport tools can be grouped in three, namely related to:

- **Environment/climate**
  - **External costs from emissions** is a desired result, as it could contribute to increasing attention on climate reporting among customers.
  - **Change in CO2** in different years, desired for the same reason as above.
  - **Share of emission free vehicles** (the transport mode share) is desired for calculating petrol tax and taxes to the government, as well as related to emissions.
- **Size and extent**
  - The **number of trips to and from an area** is desired in order to make the magnitude of urban freight more tangible for decision makers and predicting future volumes.
  - **Freight transport performance** in terms of **tonnes-kilometres** (transportarbeid) is a desired result in order to follow up on the zero-growth goal through the development of organization of transport and expect future organization, in order to calculate transport benefits of measures and calculate accident cost.
  - **Freight transport performance** in terms of **vehicle-kilometres** (trafikkarbeid) is also a desired result to follow up on the zero-growth goal through the development of organization of transport and expect future organization.
  - The **relationship** between these two, and development of the relationship, is also desired in order to follow up the same as above.
- **Freight transport performance**
  - The **number of trips to and from an area** is desired in order to make the magnitude of urban freight more tangible for decision makers and predicting future volumes.
  - **Freight transport performance** in terms of **tonnes-kilometres** (transportarbeid) is a desired result in order to follow up on the zero-growth goal through the development of organization of transport and expect future organization, in order to calculate transport benefits of measures and calculate accident cost.
  - **Freight transport performance** in terms of **vehicle-kilometres**(trafikkarbeid) is also a desired result to follow up on the zero-growth goal through the development of organization of transport and expect future organization.
  - The **relationship** between these two, and development of the relationship, is also desired in order to follow up the same as above.
  - **Change in travel time** including time parked and time in loading/unloading zones, is desired for calculating transport benefits of measures, to be able to prioritize projects. This could include time

looking for parking as well.

- The **effect on different vehicle types** is desired in order to analyze how measures affect the distribution efficiency.
- **Volume per sending** is desired as it affects the operator cost and organization of the transport.
- **Change in operator cost** is desired in order to calculate potential benefits for the urban freight carriers. Related to the volume per sending and travel time.
- **Change in accident cost** is desired in order to calculate potential benefits for the society. Related to the freight transport performance.

Based on the previously discussed findings on needs and desired measures to evaluate and results, the analysis tool can be described related to some main aspects:

Spatial resolution
The planners addressed how smaller zones are needed. They do however experience that the difficulty is to obtain detailed enough data, and that the tool would become heavy with too high resolution. Furthermore, they pointed out how a higher spatial resolution can enable integration with RTM.

Seeing this in relation to the literature, it is clear that the spatial resolution of a potential analysis tool will be a trade-off between high accuracy, resources for data collection and heavy model operations, and needs consideration.

Temporal resolution
Simulating the transport over the hours of the day, or inside and outside peak hours (as RTM) should be possible, to meet the needs of the planners and researcher.

Incorporating time differentiation in an urban freight transport analysis tool, being useful for analyses on urban scale as it enables more time differentiated measures, reflects the literature (Hansen et al. (2017); Mjøsund et al. (2020)). However, in line with the spatial resolution, there are different ways of implementing the time differentiation, and what level of detail that is most appropriate, needs thorough consideration.

Vehicle fleet
Furthermore, the planners expressed how an analysis tool needs to differentiate more than today, modelling costs and characteristics of transport modes, and differentiating on environmentally friendliness, e.g. contributing to model emissions.

The literature review has shown that there are a range of indicators of city logistics that are dependent on or regards the vehicle fleet directly (see table 2.1). In order for an analysis tool to be a helpful tool for these indicators, the tool should reflect the level of detail needed for the vehicle fleet, in line with the interviewed planners' view.

Capturing the heterogeneity of urban freight transport
To reflect the urban freight transport, the planners addressed that a tool should enable including more sectors, e.g. defining renovation as a goods. This would however require a high resolution of pick/up delivery points. Including service transport as similar to home deliveries, is also mentioned as useful. Furthermore, including interaction between passenger and freight traffic is useful to be able to model possible future innovations/solutions, and enable exploiting free capacity.

One of the planners mentioned a challenge of an urban freight transport analysis tool being how to balance the simplification of the freight traffic, as the different commodity flows in the city have different characteristics: "as several of us have mentioned, there are different freight values, deliveries and logistics chains for each of these freight groups, and they can have completely different constraints in terms of both modeling them and modeling them in a fair/correct way" [23]. As some of the other planners have mentioned, it is therefore

[23] "som flere av oss har vært inne på, finnes det ulike vareverdier, leveranser og logistikkjeder for hver av disse varegruppene, og de kan ha helt forskjellige vilkår med tanke på å både modellere de og modellere de på en rettferdig/korrekt måte"

useful to start dealing with the complex problem one step at a time, not starting with a tool that should cover everything.

Capacity on the road links
The tool being able to include the aspect of queues was mentioned by the planners in order to capture the benefits of removing queue by targeted measures.

Interaction with other tools
By having the same or compatible spatial/temporal resolution, the planners pointed out how an urban freight transport analysis tool could interact with a regional/national tool. This would enable using the results from this tool in others, or using inputs from other models (such as RTM/NGM/city models in Aimsun) in this urban freight transport tool, which they highlight as useful in understanding the holistic system and transport chains in city logistics.

Looking at the freight in a broader perspective, the analysis tool should represent the link between urban deliveries and the whole logistics chain, in line with the literature, and the planners' view on how they want to use the tool in combination with other tools. Taking into account how urban freight transport is part of a larger freight chain, it would therefore benefit from being able to interact with other models.

Relationship between the characteristics of the tool and potential for releasing benefits and more sustainable city logistics
How well an analysis tool will help planning, will affect whether it contributes to sustainability. This is related to the characteristics of the tool, which is related to the data that is possible to acquire and exploit. The analysis tool must have the right resolution for evaluating the relevant measures, and give results that can be used for decision making. With regards to the spatial resolution, it will be a trade-off. Larger zones give larger uncertainty with regards to the commodity flows in the city, but more certainty with regards to the data basis for the analysis tool. Smaller zones give smaller uncertainty with regards to the flows, but larger uncertainty for the data. Zone internal trips also need to be considered. As discussed by (Hansen et al., 2017), and found in the interviews, too high spatial resolution will give a tool that is heavy, and potentially has larger margin of error. Simultaneously, higher spatial resolution than today is needed, and some aspects in urban freight will need high spatial resolution. The measures mentioned need high temporal and spatial resolution. The measures mentioned correspond to the solutions presented by carriers, and it can contribute to sustainability if these are evaluated. The resolution of the available data that is required, decides the accuracy. Delivery data on deliveries on address level, will e.g. enable that spatial resolution.

Another aspect affecting the potential for better city logistics an analysis tool will give, is the trade-off between simplifying the model, and capturing its complexity. Some of these aspects mentioned by the planners, and indicated by the carriers, is the trade-off between simplifying the urban freight vs capturing its heterogeneity, which there is a need for. This is with regards to the commodity flows, and which should be included. If commodity flows from other sectors is seen to be required, their motivations and willingness to share data as well as what their data is like, must be researched in order to map the alignment of goals, and ensuring good collaboration. Furthermore, the heterogeneity in terms of vehicles included is an important aspect of the tool. This seems to be easier to model, based on the planners, but will require data from other actors, with the same implications. When simplifying the urban freight transport, it will require a balance, knowing what are the most important aspects of the transport, but important for what? This is related to the delimitation of the model, as representing the whole urban freight transport realistically would be too complicated. And perhaps not the most useful, as there probably is a limit of how detailed the tool should be. Regarding the characteristics of a model, and how it would enable sustainability, the findings are in line with the literature, specifically the importance of multi-modality, in terms of truck modes and transport purposes, and the relation between passenger and freight transport presented by Ogden (1992, p. 264), as well as the temporal resolution and possibility for modelling mentioned by Mjøsund et al. (2020).

The planners do propose some conflicting views on what is realistic for an urban freight transport analysis tool to be able to do. Regarding the type of analysis tools, and whether it should be a transport model, a public

planner says: "With regards to understanding city transport, it could be that for a range of analysis needs, it may not be a model that is required. I think this is starting to be so complex, (...) and it will be difficult to calculate a cost benefit in socio-economic terms regardless. I think that will be almost impossible" [24]. This problematizes the wish that several planners and the municipality have expressed for quantifying the potential benefits of measures, that they are now not able to model. The fact that one of the planners thinks calculating the benefits is not possible, while exactly the benefits are wanted from many, should also be considered, and researching how to capture the complexity in a simplified way, will be important.

The realization of the benefits is to a high degree related to the relation between the tool and understanding the situation of those planning/executing the transport. The tool will be valuable if it enables the actors involved to actually gain insights into the current situation for the other actors, and enable them to change their thoughts. This is related to how a tool can help actually visualize the potential problems/situations for urban freight transport, preferably in relation to other transport and the city, enabling solutions that actually target these problems. This is in contrast to focusing on the solutions, before having accurate knowledge on what needs to be solved. By enabling the planners/authorities to understand the needs and situation of the important carrier actors involved in city logistics, the tool can improve the situation. This is important to note as therefore collecting data only, is not enough. The connection between the data and the insights it is meant to give for what understanding and improvements, is essential, in terms of knowing what and why, as well as how, an analysis tool should be developed to best realize benefits. A tool should therefore not only present the situation, but also help to realize new ways to improve this situation, by helping the users see interconnections and gain understanding for creating the measures that can solve the right problems. This means connecting the data and analysis to gain insights, as well as the next step; using this insight to create solutions that give value - either for the society and/or the carriers, preferably both.

It is therefore important to note that both private and public planners, and the researcher highlight that before developing an urban freight transport model, it is necessary to have thorough knowledge on and mapping the situation of urban freight transport in the cities today, as well as having knowledge on data/approaches that would be required to map today's situation. When the current freight situation is known, a tool that can help long-term can potentially be developed. This indicates that the planners/researcher see potential in a model, however, that right now, the knowledge is not mature enough, and that it is not appropriate to develop a tool without doing thorough work first.

4.2.3 Data for a tool

With the interviews, the planners and researcher expressed a need for data than can be characterized as data on deliveries, and data on the vehicle fleet. As described, the resolution and availability of this data will affect the characteristics of an analysis tool, in turn affecting what benefits can be achieved. On deliveries, the following data is mentioned by the planners and researcher:

- Data on the **volumes delivered**, combined with quantities of the deliveries. This includes how many packages and units the delivery consists of, from who, whether it is a city terminal or distribution from post in grocery stores or B2C (business to consumer) etc.; as well as to whom, whether it is different offices/buildings, cafes or industry etc. This is needed in order to generate and analyze commodity flows. The data does not necessarily have to be on address level, but a level that is suited for relating the commodity flows to.
- Data on the **time stamps**, to evaluate delay and effect of capacity problems/peak hours, and see when the demand is highest, and/or weigh the benefits according to time of day.
- Data on the **number of vehicles** doing the delivery.

[24] "med tanke på å forstå bytransporter, kan det være at i en rekke analyseoppgaver er det ikke sikkert at man skal sikte seg inn mot å lage en modell. Jeg tror dette begynner å bli så komplekst, (...) og det vil uansett være svært vanskelig å regne seg frem til en nytte av tiltaket i samfunnsøkonomisk sammenheng. Det tror jeg nesten er helt umulig"

- Data on the **distribution pattern**, in the case of the construction and grocery sector to a large degree the regular routes.
- The **number of stops**.
- The **time use for stops**.

On the vehicle fleet, the public planners mentioned the type (including fuel), size and number of vehicles. This shows a link between the delivery data and vehicle fleet data, as the vehicle data for the delivery would be a subset of the vehicle fleet.

This data would therefore be the most valuable to obtain for the development of an analysis tool.

4.2.4 The future of urban freight transport

The expected trends to affect the organization of urban freight transport, says something about what a tool should be able to handle, in order to also be relevant in the future. As one of the planners expressed, changes are expected, and understanding these are important: "I think it will be important to be able to see the impact of logistical changes in future, there are simply a lot of big changes happening" [25]. The trends mentioned by the planners affecting urban freight transport modeling are:

- **Innovation**, especially in the large cities. This contributes to data expiring fast, affecting the data collection for a tool.
- More **energy- and climate efficient transport**. This can affect the air quality, but not necessarily the road capacity. The cost model for the analysis tools could be adjusted to include these modes.
- **Smaller vehicles**, which also affect the air quality, but not necessarily releases road capacity.

In addition, trends the policy maker thinks will affect future city logistics are less space in the cities, meaning less area for loading/unloading and solutions that combines the businesses and the transport business (næringslivet og transportnæringen). These are trends that do not necessarily affect the modeling of urban freight transport, but could be affected by the outcomes of a tool.

The trends reflect many of the measures desired for analysis, as these are related - the planners need tools to analyze the trends they see will affect the urban freight transport, and that are difficult to evaluate without data and a tool. This underlines the importance of including more transport modes (vehicles in different sizes and fuel types), being able to analyze different measures capturing the innovation, and need for it due to battle for space, and the fact that it includes the perspective of the carriers. The latter reflects how a tool should identify economic benefits.

As there is a lot of focus on smaller vehicles, the desired ratio suggested by a planner might be an important indicator: "is the situation that the transport work can increase because you can add more to the load, with larger vehicles – or rather the opposite, which is more popular now, increasingly more small vehicles, which means that you need to wheel out a lot of cargo bikes and special vehicles in the other end in order to deliver? The development of that ratio, transport work over traffic work, or the other way around, needs to be monitored. (...) I think it is not necessarily a problem if the transport work increases, as long as the traffic work doesn't. With the zero-growth target, which may influence the way we organize ourselves in future, indicators like this will help us monitor that" [26].

With innovation in the vehicles, such as cargo bikes, the accessibility aspect's importance also increases: "accessibility in this context may mean by foot (from the parking place to recipient), but also by bike (e.g. from a city logistics depot to the recipient). One measure of walking accessibility/bike accessibility may be how

[25] "det å kunne se virkninger av logistikkendringer tror jeg er viktig fremover, det skjer rett og slett ganske store endringer"

[26] "Er det sånn at transportarbeidet kan økes fordi du får med mer på lasset, med større kjøretøy – eller snarere tvert imot - som er moderne nå, med stadig flere små kjøretøy, som gjør at du i andre enden er nødt til å trille ut masse lastesyker og spesialkjøretøy for å få levert? Utviklingen til det forholdstallet, transportarbeid over trafikkarbeid eller omvendt, det bør man følge med på tenker jeg. (...) For det er ikke nødvendigvis noe problem tenker jeg, om transportarbeidet øker hvis trafikkarbeidet ikke øker. Med nullvekstmålet, som kan påvirke måten vi i fremtiden organiserer oss på, vil sånne indikatorer hjelpe oss med å følge med på det"

many targets (recipients) you reach within a given travel time/distance from a starting point (the parking place, city logistics depot)" [27]. Including this aspect, might therefore be increasingly important. This is also with regards to the multimodality in terms of walking and transporting with a vehicle. Incorporating the innovation somehow, is important in order to reach the benefits for the public authorities.

The trends can also say something about which sectors that will be important to include. One private planner mentioned how: "ideally we should perhaps see all (sectors) in one, but (...) perhaps renovation and goods delivery is the most important and what will increase the most" [28]. They have similar characteristics, as freight delivery also bring back returned goods. Furthermore, the manufacturing industry and production is located more in the periphery, and less important for urban freight transport. Home services are also relatively constant. A challenge for modelling the commodity flows within urban freight is when the location of destinations/the flows vary in geography, such as to construction sites and mobile services.

The trends seen by the carriers are in general in line with the trends mentioned in the literature. However, the carriers have conflicting views on some of the trends, indicating that the trends are not clear. Several of the trends reflects the challenges, and how the carrier expects these aspects to become more challenging in the future. The challenges mentioned by the carriers during the interviews are:

- **Regarding time windows:** The carriers experience that customers want smaller time windows. The deals of many of the larger customers/chains are negotiated centrally, for efficiency reasons. The logistics carriers mentioned how more customers want time windows, as predictability is being increasingly important.
- **Smaller vehicle units in the city centre:** The grocery carrier points out how smaller vehicle units are challenging for them due to temperature regulations, and only relevant for customers where one carrier delivers smaller deliveries, not full loads.
- **Unattended reception points (varemottak)** that can be delivered to at evenings or nights. The carriers think that this is most relevant for larger customers.
- **Common reception points:** The carriers also see this as most relevant for larger customers like shopping centres, combined with unattended deliveries, mentioned by the grocery carriers.
- **Related to more regulations:**
  - Demands about car-free zones, mentioned by both grocery and logistics carriers.
  - Demands about environmentally friendly vehicles that are fossil-free, and demands coming both from the authorities and from the companies themselves, experienced by both grocery and logistics carriers. Several of the carriers is stating how their vehicle fleet is becoming more environmentally friendly, with less fossil fuel. This however increases to the heterogeneity/complexity.
  - Demands that only a limited number of last-mile distributors can distribute. The carrier thinks that this can happen as a result of setting the demands for vehicles.
  - More regulations on what time deliveries are allowed to be made.
- **More e-commerce:** The logistics carriers see this as a future trend, leading to more home deliveries, often on evenings, and more pick-up points.
- **More carriers specializing in last-mile delivery:** The carrier points out how these are using technology to be efficient, and that this increases the needs for common hubs.

[27] "Tilgjengelighet kan i denne sammenheng være gåtilgjengelighet (fra parkeringsstedet til mottakere), men også sykkeltilgjengelighet (fra f.eks. et bylogistikkdepot til mottakere). Et mål på gåtilgjengelighet/sykkeltilgjengelighet kan være hvor mange målpunkter (les: mottakere) man når innenfor en gitt reisetid/distanse fra et utgangspunkt (les: parkeringsstedet, bylogistikkdepotet)"

[28] "Ideelt sett burde man kanskje sett alle [sektorer] under ett, men (...) kanskje renovasjon og varelevering er det viktigste og det som vil øke mest"

- **Price differentiation between rural and urban areas:** A logistics carrier thinks that in order to compete with the specialized carriers in urban areas, they will have to price differentiate.
- **Customers increasingly wanting to send from home:** is affecting the logistics carriers.
- **Much of the trade and activities moving to the suburbs, where it is more convenient for cars** is mentioned by a logistics carrier.
- **Larger degree of autonomy** is mentioned by a grocery carrier.
- **The large actors having to lead the development, together with customers and authorities** is mentioned by a grocery carrier.

The drivers behind the trends are according to the carriers

- Sustainability, mentioned by the carriers within all sectors.
- That the customers want to do everything from their couch, mentioned by the logistics carriers.
- Minimizing costs, mentioned by carrier within the construction sector.

The future transport systems are expected to be more flexible, due to several trends like the Covid pandemic and changed user preferences. On the one hand, this increases the need for tools to do analyses and projections as the flexibility makes the transport more complex, and setting different data in context are expected to give new knowledge, as the literature and results says. On the other hand, this flexibility and complexity makes the transport more difficult to capture and simulate.

Related to the increase in e-commerce, leading to more home deliveries and pick-up points, it is interesting how one of the logistics carriers explain the last-mile in their B2C (business to consumer)-segment: "'last mile' there works differently from B2B. (...) 90% of what is delivered today ends up at a pick-up point. This means the distribution does not reach the end customer, but just the pick-up point, and then you pick it up yourself" [29]. They bring the B2B and B2C deliveries together into Trondheim, but after that the final distribution is different. Since most of their B2C deliveries goes to pick-up points (post i butikk), of which they have around seven in Trondheim city centre: "It is much easier to optimize with very few end customers" [30].

4.3 How can and should data from the carriers be obtained in order to enable these analyses?

The literature and interviewed planners seem to agree on the fact that more knowledge on urban freight transport is needed for better city logistics planning, and that carrier data is one form of data that can contribute to that knowledge, however, using this data is not widespread. The literature and planners agree that this is related to the difficulty in obtaining it, which impacts how the urban freight data is collected today.

How data can and should be obtained therefore have two aspects to consider: both how data can be collected while complying with the carriers' terms, and that it should be collected in a way that it is useful for planners/researchers/public authorities. These two aspects are however related. The data has no value before it is utilized in analyses to provide needed knowledge.

This third research question will be addressed on the results from both of the interview groups and the data analysis.

4.3.1 Obtaining data from carriers

The carriers had different attitudes towards sharing data. This can to some degree be subjective, dependent on the experience of the interviewees. Regardless, is it likely that the variation I have found, can reflect the

[29] "'last mile' der fungerer på en helt annen måte enn B2B [business to business]. (...) 90% av det som leveres i dag havner i pakkeboks eller post i butikk. Det betyr at distribusjonen der ikke skjer ut til sluttkunde, men først og fremst bare til post i butikk, og så henter du varen selv."

[30] "Det er mye enklere å optimere og veldig få sluttkunder"

variation within the field. All of the opinions are therefore interesting. However, overall, the carriers were positive, as long as selected conditions are fulfilled. Several aspects are discussed as reasons for being reluctant to share data, and as contributing to concerns about data sharing:

- Sharing must **benefit the carriers**, in terms of better planning/facilitating etc.
- The goal of the data collection must be **better city logistics,** including improved distribution conditions for the carriers.
- Complying with the data sharing terms, ensuring **data security.**
- **Anonymization** and on **aggregated level**, complying with market considerations.
- **"All" carriers contributing** with data.
- Need to have defined what the data will be used to - **a plan and purpose** for the data, **clear framework** and **boundaries** for the use.
- The data should be **easy to access and extract** from the carriers' systems.

With the increase in focus on urban freight transport the latest years, a number of projects within the field have been carried out, of which many need carrier data. One of the aspects is **data having been shared with private projects and the municipality/county many times, without seeing results from it**: "it seems to be a bit of an attitude from the carriers, at least from our side, that gradually many of them [consultants] ask for data (...) and I personally feel that the only ones that have benefitted from this review are the consultants themselves. Not the industry, and not the ones we serve, who are businesses and customers in the Trondheim area" [31]. This shows how being asked for data repeatedly and not seeing results, affects the attitude of the carriers negatively.

This is related to not seeing the value from previous data having been shared. Regarding the fact that the carriers have to **see value in sharing the data**, the quotation of one of the carriers: "if a consultancy gets a contract, they get well paid for that job, but they have to get the data for free from us carriers. In many ways we feed the consultancies data sets, which means they can earn money" [32], showing how their attitude towards sharing data can become negative if they do not see that they get anything in return. Sharing data gives value in terms of making the decision makers in Trondheim take into account the urban freight transport, as it is clear from one of the conditions of sharing data is important for the carriers: "if those who make plans in the city centre have a better basis for decision making than they have today, that is positive" [33] and this will help the challenge of: "across the industry the experience is that business is forgotten about in city planning" [34]. On value of sharing data, one carrier said "access to data that makes it possible to analyze or to show analyses in order provide a better basis for decision making related to what to consider with regards to deliveries e.g. in the city centre" [35].

Data security also is a repeated concern: "we never know if we supply data, although we say they should not be passed on and be anonymized, then it is difficult to say what happens with the file we send" [36]. This repeats the concern about sharing tracking data: "and when we release the data, that is out of our business, and for example to NTNU or to you, then we are concerned we may break some conditions" [37].

[31] "Det er nok litt holdning fra transportørene, og i hvert fall vår side, at etter hvert er det mange som spør om data, (...) og jeg sitter personlig med følelsen at de eneste som har tjent på denne utredningen er konsulentene selv. Ikke bransjen, og ikke de vi betjener, som er bedrifter og kunder i Trondhiemsområdet"

[32] "Hvis et konsulentfirma får et oppdrag fra en aktør, så tar de seg godt betalt for den jobben, men datagrunnlaget må de få gratis fra oss som transportører. Vi sitter på mange måter og forer konsulentfirmaene med datagrunnlag, som gjør at de kan tjene penger. Det er ofte i prosjekter at de ønsker kunnskap kun vi transportørene har"

[33] "at de som skal legge planer i Midtbyen har et bedre beslutningsgrunnlag enn man kanskje har, er bra"

[34] "Gjengs over i bransjen er opplevelsen det at man glemmer næring når man planlegger bybildet"

[35] "tilgang på data som gjør det mulig å ta analyser eller vise til analyser for å gi et bedre beslutningsgrunnlag knyttet til hvordan vi skal ta høyde for ting når vi skal ha leveranser, f.eks. i Midtbyen"

[36] "Vi vet aldri hvis vi sender fra oss sånne data, selv om vi sier at det ikke skal sendes videre og anonymiseres, så er det vanskelig å si hva som skjer med den filen vi sender fra oss"

[37] "Og når vi slipper den dataen fra oss, altså ut av vår bedrift og f.eks. til NTNU eller deg, er vi redd for at vi bryter noen vilkår."

Anonymization is pointed out as especially important: "as soon as we share data, in principle in many ways we share trade secrets. We share what customers we have, how much goods we deliver, and how much goods the customer receive. So we share not only our own trade secrets, but also that of our customers, which may make me worried" [38]. The anonymization is therefore both for the carriers' sake, and for the sake of their customers.

The anonymization is needed in order to **comply with market considerations**. Aggregation is then important: "the report cannot be so detailed that you can track a single car or delivery, but must rather be at an aggregated level in order to see trends and developments" [39]. That "is connected to protection, you may get lots of data, but the data must be aggregated up to total data for Trondheim, you cannot be able to see that there is DHL, or Posten driving; the industry won't accept that" [40]. The carriers are protective of their data, as it is their competitive advantage, in a way that if other carriers got data on where and what one delivered, volume and average weight is mentioned specifically by a logistics carrier, they might want to challenge them, competing for customers etc. Within the sectors, the carriers are competing for the same customers, of which some are more attractive than others, with regards to freight that is "easy" to carry, etc.

Another aspect mentioned is that the data is **collected from many carriers**. One of the logistics carriers say "all the larger logistics carriers need to be involved. It doesn't help if we are the only ones, the others need to be the same" [41], and another that "it feels wrong if only one carrier is sharing data" [42]. However, one carrier problematizes the fact that this can be difficult: "at the same time, there is a lot of transport both in and out of Trondheim and other places which we don't have data for, as there are incredibly many actors. And there are a lot of companies who still run their own transport within their own business, so in that sense we are only a small picture of the total transport picture" [43]. With regards to "the "dugnad", all contributing, one carrier suggests: "if a municipality is to collect data, they have to take the data from the largest operator and calculate their market share, e.g. 70%, and then add the volume for the others e.g. 30%" [44]. To not only have some of the numbers.

Furthermore, it is noted that the data collection has to be part of a plan, so that it is **clear what the purpose of the data collection** is. "To share data in general can be valuable if it is linked to an overall plan for freight transport in cities. You cannot just say that we should supply data, you need a plan for what the data is used for, a goal" [45]. When the data need from the carriers is expressed clearly from them, doing the data extraction, and evaluating how they can contribute, is easier for them. The quote of another carrier also illustrates the importance of clearly communicating the purpose of the data sharing based on previous collections: "that's perhaps what has been unclear among those have collected data as well, what it actually is going to used for, and what the aim is of collecting data. Is it just to collect data, or is it going to be used for decision making subsequently?" [46]. If the data is used for explicit planning purposes, and that purpose is well communicated, "concrete and clear" the carrier saw value in sharing data: "then we'd contribute to providing the data, of course. (...) There is no help in dealing with data if it isn't going to be used for anything" [47].

[38] "Med en gang vi deler data, deler vi på prinsipielt grunnlag på mange måter forretningshemmeligheter. Vi deler hvilke kunder vi har, hvor mye gods vi kjører ut, og hvor mye gods kunden har. Da deler vi på mange måter ikke bare våre forretningshemmeligheter, men også våre kunders, og det er kanskje det som gjør meg mest betenkt."

[39] "rapporten kan nødvendigvis ikke være så detaljert at du kan gå ned på enkeltnivå og spore en enkelt bil eller leveranse, men mer på et aggregert nivå for å se trender og utvikling"

[40] "Har sammenheng med beskyttelse, du kan få masse data, men dataen må aggregeres opp til total data for Trondheim, kan ikke se at der kjører DHL, Posten etc., det aksepterer ikke bransjen"

[41] "Alle større samlastere må være involvert. Hjelper ikke at bare vi er det, de andre må osgå være det samme."

[42] "det blir litt feil hvis bare en transportør skal dele data"

[43] "samtidig er det voldsomt mye transport som foregår både inn og ut av Trondheim og andre plasser som det kanskje ikke finnes noe spesielt konkrete data på, siden det er så utrolig mange aktører. Og det er mange bedrifter som fortsatt har egne transporter innen egen virksomhet, så sånn sett er vi bare en liten del av det totale transportbildet som er i Norge."

[44] "Hvis en kommune skal samle inn data, må de jo ta dataen fra alle de største samlasterne og på en måte beregne hvilken markedsandel de har, f.eks. 70%, og legge på volumet fra de andre, da f.eks. 30%"

[45] "Å dele data generelt kan være verdifullt hvis det knyttes sammen med en overordnet plan for vartransport i byene. Du kan ikke bare si at vi skal levere ut data, man må ha en plan for hva man skal gjøre med dataen, et mål."

[46] "Det er kanskje det som har vært utydelig blant de som har samlet inn data og, hva det faktisk skal brukes til og hva som er målsetningen med å samle inn data. Er det bare å samle data, eller skal det brukes til noe beslutningsmessig i ettertid?"

[47] "er det konkret og tydelig, da vil vi bidra å skaffe data, klart det (...) Det hjelper ingenting å holde på med data om det ikke skal brukes til noe."

This is related to another aspect, the level of ease related to the data sharing is important - it **has to be easy**. As described for the data extraction, several of the carriers do not have resources to contribute to data sharing. The central IT-divisions are the ones who will be in charge, and they want to use their IT resources on development, rather than time-consuming data extraction, as they have examples of now.

It was an initial thought that maybe sharing historical data could be a condition, and it was suggested in the interview guide. However, this was not mentioned by any of the carriers.

This can tell us that

- More holistic data collection and sharing of the data would contribute to the carriers not having to share the same data repeatedly.
- Having good routines for data security is important to gain and keep the trust of the carriers.
- Sharing data have to demand little resources from the carriers side. Sharing data is not their main concern. However, it ties to the fact that they also see value in it for them.

The planners and researcher point out several of the challenges of data availability that the literature indicates can be reduced by using carrier data, such as the time-consuming survey data collection, lack of comparable data and costly data collection, outdated data, and the spatial resolution for data (Patier (2008); Hovi et al. (2016); Natvig et al. (2016); Otte, Solvay and Meisen (2020)). The planners also discuss several challenges that can be classified as related to obtaining data from carriers, as well as possible solutions to these. One of the challenges pointed out by the private planners is the numerous commodity flows in a city, that makes the number of contacts to ask for data very many. The planner mentioned getting data from the largest logistics actors such as Postnord, Bring and Schenker possibly being enough, as a possible solution. Furthermore, the planners noted how the fact that transport chains are different makes them difficult to incorporate together, for example some use logistics actors, and others don't. Another challenge for obtaining data that is noted is the competition among the carriers within the same sectors, competing for doing the transport for the same customers, being the most efficient and punctual carrier, making them protective of their data. The planners noted a possible solution being to collect data with common standards from a public user perspective, nothing affecting the market, and no distortion of the competition (konkurransevridning), in order for the data sharing to not affect the actors. The legal aspect of data sharing is also highlighted as a challenge. Furthermore, the lack of willingness to share data is mentioned. A solution noted by the researcher is that the one who is to collect the data have to know what data is wanted and convince the carriers that it will be used for better city logistics, and not in a competitive situation.

One of the findings of the study is that both those providing the data and those using the data state that it is important to minimize the resources needed to collect the data, including the cost of updating data. This is due to the lack of budget and time for data collection for the planners, and the carriers being most concerned with their own operation. It will require initial work to set up the collection, and the carriers needed to give time for adapting their systems, in line with London Data Commision (2020, p. 26) highlighting defining data-sharing principles early as a success factor for data-sharing. The data therefore have to be collected in a way that makes it economically motivational to share, including resources spent to adapt their systems.

The fact that it has to be relevant for explicit planning needs, confirms the literature. Collecting data that is not used is costly and affects the satisfaction of the collaboration with planners. Collecting data in line with what the planners have said and the carriers want, as discussed in question 1, helps ensure this.

The example of collaboration for better urban freight transport in Elskede by, shows that the motivation for the participants is similar to the motivation of the carriers, and the same roles have the same perspectives. This contributes to indicate that the results can be applicable other places in Norway, or places with similar structures.

The literature suggests legislation for data sharing. The carriers themselves expressed that they expect there being set demands related to environmentally friendly transport, which can help "prepare" them for these

regulations. However, this would be a regulation that demands something from them, and then the conditions for sharing data have to be in place for them to be positive. The literature pointing to the idea of obligatory data sharing and study findings on how some carriers expects demands, also show that this is a possibility. However, the literature do have conflicting view on this, as research also indicates that solutions based on collaboration rather than regulation will be easier to implement and create more benefit, as this will be more accepted among the carriers. This should be considered in light of representativeness of data, achieving that as much as possible. Collaboration between the public and private sector is pointed out as important for data sharing (Browne and Allen (2006*a*); (Patier and Routhier, 2008); European Commission (2013); Allen and Browne (2016)), so regulations should in any case not feel forced.

However, the bottom line can be that regardless of whether data sharing is implemented through regulation or collaboration, creating mutual benefits is key in literature and empirical results (Allen and Browne (2016); London Data Commision (2020); Otte, Solvay and Meisen (2020)). The benefits have been identified in figure 4.2 and discussed in subsection 4.1.2.

These benefits are in line with how the urban freight actors see potential for reduced costs and increased transport efficiency (Langeland (2021)), contributing to achieve these possibilities. However, as they see costly economic investments as a challenge, giving time for adaptation of their systems and researching thorough how and what data is needed, can contribute to reducing these initial costs as much as possible. And then ensuring that the rest of the process is not very resource demanding. In general, this study's findings illustrate how it is important to utilize the potential for technological developments that can enhance the transport.

The importance of communicating these benefits is evident from the literature and the empirical evidence. This shows potential, it just requires a definition of the data need and why it is needed. This project experienced first-hand that the data need had to be stated very specifically for the carriers for them to show willingness to share the data.

An incentive can also be making them understand the long-term effects of sharing data (Natvig et al. (2016)). The carriers interviewed seem to have an understanding of this now, which might be an effect of the focus on sustainability in all parts of society today, and be related to how they are motivated to share data as long as it improves their situation, and the knowledge of their transport situation among the public sector. They therefore seem to understand the fact that lack of data sharing contributes to the decisions complicating their work situation and health and safety of their drivers.

All carriers shared data to this project, and under these conditions, and would be willing on a larger scale. So, the fact that it seemed to be easier to obtain delivery data than previous projects, can be that there has been a development in willingness to share data. It has been established that carrier data can benefit urban freight transport modelling, but from what is found in this study, it can be possible to go beyond what has been done previously. However, the access to tracking data was not easy. This is an interesting finding. The literature proposes a large potential in what tracking data could enable, and identifies projects that have collected tracking data, both in Norway and abroad, which is interesting as tracking data access could be related to legislation regarding tracking data. But this study indicates that acquiring the tracking data on a large scale is not so easy, related to the described finding on anonymization and protection of the drivers' privacy.

This tells us that

- Whether an urban freight model/analysis tool gives value to the carriers, depends on its purpose and use.
- Whether the model/analysis tool gives value to the carriers, is a crucial factor to whether they share data or not.
- The purpose being identified and clear, and well communicated to the carriers, is therefore key to get access to data, and unlock the value.

This indicates that thorough research must be done on how a model/analysis tool could be built in terms of what it can do, before asking for data on a large scale from the carriers.

Obtaining vehicle data specifically

Register number and tracking data were asked about specifically in some of the interviews. The register number could be useful to have for doing extractions from vehicle databases. One interviewee said that they would have to check with the ones that own the vehicles, whether they can share it or not. This is an indication that the carriers might not be the right people to ask for this information, as many do not own the vehicle fleet themselves. However, they have overview of the vehicles that are mainly used, but do not know if they can share the data. This points to that others in the transport chain have to be contacted for the full picture. GPS tracking data was asked about specifically as the literature have pointed out the relevance of this data. All of the interviewed carriers have some sort of tracking that they use to their appropriate purpose. All of the asked carriers either expressed doubts that this data can be shared or states that it cannot be shared, due to privacy reasons and sensitive deals with the drivers, and strict terms of collecting and using the data from the union. One of the carrier expressed how they "are hardly allowed to use the tracking ourselves (...). We have constraints ourselves on who can access it" [48], and another "The reason we are so afraid of the GPS-scheme is that all transport companies have had a clear message from public authorities that GPS data is to be treated sensitively. The unions have come out in front, as they are concerned it gets used for surveillance" [49]. If it should be possible to share, one carrier says "it would need to be included in the employment contract, whereby drivers are employed on the conditions that we can see where the cars are at any time" [50]. Furthermore, one carrier says that it is not their vehicles, so it is not decided by them, in line with the discussion on register number.

With regards to other vehicle data, one of the logistics carriers expressed how the data quality would decrease if they included the vehicle ID, because sometimes the carriers they are using have one of the vehicles on service, and they use another. The information would therefore not be valuable in their systems when others do the transport. Furthermore, the delivery data are used by them for planning purposes, and they plan the vehicles (and accordingly size) based on these deliveries, and not the opposite way. The carrier states that after a while, seeing that on one route the volume was this or that, should enable you to understand what sized vehicle is needed.

One of the logistics carriers say they in the past, and present, is very willing to share data on their own vehicle fleet. Contrary, sharing data on the vehicles that are used by their carriers, is not as easy. This is part of their customer relationship with those carriers. Therefore, this further indicates that the carriers doing the transport have to be included to get vehicle data, such as register number and tracking data. Simultaneously, the carrier points out how the contracts describe the relation, and adapting the contracts might be useful for them in order to ensure sustainable transport (more about this in the section about future transport).

Access to tracking data could in this study be seen in relation to the conditions the carriers expressed for sharing data, as clarifying how the tracking data would be used, received and handled in this way, could change the attitude of the carriers. As this question relates the vehicle fleet to a large degree, the findings can also indicate that the carriers owning and operating the vehicle fleets are the correct ones to ask.

Getting access to tracking data/GPS data does not seem easily available at this time. Access to tracking data might have to be decided on a higher level, e.g. the unions changing the terms. The tracking data is regarded as sensitive, but should be possible to get without the info on the drivers.

4.3.2 Potential for automation of data extraction from the carrier delivery data

The potential is investigated through the interviewed carriers' data use. The data use varies between the interviewed carriers. One of the companies have a large IT-unit, driving forward the development, while in another the data cannot be accessed from Trondheim, and that is no problem for them. In general, a lot of data is used for internal efficiency maintaining. The findings were

[48] "Har knapt lov til å bruke sporingen selv. (...) Vi har begrensninger selv på hvem som kan få tilgang på det"

[49] "Grunnen til at vi er så redd for GPS-opplegget er at alle transportbedrifter har fått klar beskjed fra offentlige myndigheter om at GPS-data skal behandles som sensitiv. Fagforeningene har vært veldig på hugget, fordi de er så redd for at det skal brukes til overvåking"

[50] "Man må ev. ha det i ansettelsesavtalen, hvor sjåførene da ansettes på premissene at vi til enhver tid ser hvor bilene er."

- All carriers use their data for planning the routes.
- Some use it for optimization.
- Some use it to do analyses as heat maps, prognoses as volume changes, for quality measurements and key numbers related to cost. This included carriers within all three sectors.

The level of ease connected with data extraction was to some degree seen to be correlated with the data use. Extracting the data they need themselves, is easy. Their data use is naturally adapted to their needs. One logistics carrier expressed it as: "we have a lot of data that we are using for internal development. And we have data systems which I feel we use well for planning, and it may not be that easy to get data out. Typically we take out and present data, and use it as a tool. But if you need a report, I feel that is a bit difficult, so then you need to go to the IT department, who can provide a data extract" [51]. The carrier thinks it is related to data being stored in several different systems, and the fact that they have so much data. The data extraction of the logistics carriers is also directed by the customers' data need.

The question is then what possibilities there are of extracting the information that planners/researchers need. Providing the data sets for this study required manual work to clean the excel sheet and/or remove sensitive information on customers. The longer time period for the data sets, the more manual work needed and time demanding it was cleaning the data. Some other challenges for sharing data, was data being stored in different reports and formats, thus difficult to combine. Data on fuel type, is mentioned as requiring a lot of manual work to combine. One of the companies who had not linked data from different programs before, however said it was likely relatively easy to do so. It was also mentioned that the geographical areas for the extraction could be a challenge, as both the urban freight transport and rest of the freight transport going into/out from the premises of the companies in Trondheim, drives on the urban freight network, as in the main network and the access road to these. This would require choosing some limiting values.

However, there seems to be possibilities to adapt the data extraction so that they fit a future data need. New reports could potentially be defined when it is seen what information is useful to include. One of the companies is already thinking that far: "we will in the future do data extractions specifically calculated for Trondheim municipality, Oslo etc. with only that [the information that can be shared]" [52]. This is in contrast to another carrier stating regarding what data they would share for the project: "then we are talking about files I have available. Beyond that, we don't have resources for this. That is because we run our business on a daily basis, we don't have resources to deploy to obtain further data. So the challenge, yours and ours, is that we have limited opportunity and time to assist in such projects. And if the data is not easily available, that is not our problem" [53].

One of the logistics carriers expressed that the demand for data among the larger customers is increasing. This reflects the literature and could contribute to easier obtaining of useful data. However, these results point to the fact that increasing data use among the carriers does not necessarily lead to easier ways to obtain data, if their data use is not in line with easier data extraction and data sharing. Therefore, starting to get the carriers to adapt their systems as soon as possible could be useful.

This can tell us that

- First what data is needed should be identified, and then the systems can likely be adapted.
- Identifying the data needs (acknowledging that they will change, i.e. are dynamic to a certain degree) will make future data extractions easy and automated for the carriers, as they can adapt their systems to it.

[51] "Vi har ekstremt mye data som vi bruker til intern oppfølging. Og så har vi datasystemer hvor jeg kanskje opplever at vi er gode til å bruke de for planlegging, og det kanskje ikke er så lett å få data ut. Typisk henter vi ut og presenterer data, og bruker det som et verktøy. Men hvis du skal ha ut en rapport om noe, opplever jeg det som litt vanskelig, da må du til IT-avdelingen som skal ta et datauttrekk"

[52] "I framtiden vil vi ta datauttrekk som er helt spesifikt beregnet for Trondheim kommune, Oslo kommune osv., uten det der [data som ikke kan deles]"

[53] "Da er det snakk om filer som jeg har tilgjengelig. (...) Men utover det, har vi ikke mye ressurser for det. Det er fordi vi driver i daglig drift hver dag, og ikke har ressurser å sette på å hente frem sånn data. (...) Litt av utfordringen din og vår, at vi har liten anledning og tid til å bistå i sånne prosjekter. Og hvis ikke dataen er lett tilgjengelig, så er det ikke vårt problem."

- The digitization maturity and use of data varies.
- This variation in data use among the carriers, might lead to some difficulties.
- The value they see in data sharing can potentially be related to the value they see in data use based on their data use.
- Adapting their data extraction systems to the need of planners seems possible.

Related to the trends being seen by the carriers, the technology is becoming more mature, and the companies need control of the data flows. IOT, and ITS, will see changes. More companies collecting data, connected devices, propose potential for data. Charles Darwin said: «It is not the strongest of the species that survives, nor the most intelligent, but rather the one most adaptable to change!», which reflects how the digitization might accelerate the data use among the carriers.In this way the development of big data can make it easier to obtain data, but only in the way that the carriers become more information driven and collect more. Getting access to it, them sharing it, will maybe require the same efforts, or become more different, if the data on their own driving and customers are likely to become more and more worth for their operation, and something they are not willing to share. For example, the value of the larger internet companies such as Amazon etc. is becoming data on their customers and their behaviour, and not their deliveries or storage. A similar development can limit the willingness to share data. Unless the carriers change attitude into the data being valuable to share, which can happen, but is not really likely, considering this competitiveness in the business and how the data is their "gold".

4.3.3 How should data be collected to benefit analyses

Challenges related to available data

When asked about available freight data, the interviewees mentioned challenges related to both data collection and data characteristics, which to some degree is related to the data collection.

The challenges related to current **data collection** mentioned by the planners are lack of budget to collect data and time required for data collection; difficulty in matching data due to different formats/definitions; and data collected only once or very few times, making data not being comparable over time or space. Acquiring data from the carriers is also a challenge mentioned by the private planners, with the implication that most projects today are more case oriented, as it is easier to obtain data for particular cases.

In terms of challenges related to **data characteristics**, the planners and researcher mentioned urban freight transport data, e.g. in the NGM, being outdated/expiring faster than passenger traffic data. Furthermore, they experience difficulties in obtaining data with high spatial resolution and from within in a city. Lack of data leads to the need of assumptions for the specific study area, with the implication that the assumptions might vary for different measures and difficulty in prioritizing funding. Another challenge is lack of data and small samples in surveys in smaller cities, leading to uncertain data grounds. Data that is available is furthermore not connected, and they experience lack of data for doing evaluations, making it difficult to learn from mistakes.

Aside from the challenges for the policy maker in securing political agreement, the public and private sector planners and researchers seem to have similar data challenges. It is, however, a tendency among the public planners to highlight challenges related to the data collection, while the private planners are concerned with the data characteristics. This can be related to how the public authorities are to a larger degree responsible for national/larger data collection than the private sector. However, both sectors do have challenges with both aspects of data. The researcher highlights knowledge on what information is needed, and lack of data for evaluations, which could help research.

Who the data should be collected from, is at the core, mentioned in the previous research question. The data analysis showed that data from several sources would be needed, in line with the literature. Natvig et al. (2016) also suggests that the freight forwarders (speditører) should be required to report. This is also related to what data is needed. One of the carriers state that data from the biggest 3PL-actors will give a thorough picture on traffic. One of the planners is uncertain as to how much information the data from the 3PL-actors can give, as

some of the commodity flows go around nodes and carriers in cases where the freight operators transport the goods directly between production place and the end customer. Several large goods owners have their own transport or dedicated contracted carriers handling large volumes that not necessarily relates to logistic carriers and nodes, even if it can be large quantities/volumes. This highlights that different actors can give different information, and that several will be needed. The delimitations of who are asked of data will be important. However, it can be assumed that the different types of actors will have a larger variation in their data than the actors that are of the same type, based on how the carriers plan their transport (see subsection 4.5.1). Different actors can give supplementary picture. There seems to be a need for vehicle data. The transport operators used by the interviewed carriers seem to have the "key" to whether this is shared. The question of who to involve is also related to the sample size, and how this is a trade-off between representative and exhaustive data, and data collection cost and resources.

There are also other approaches of attacking the urban freight transport, e.g. deriving the transport volumes from the recipients, relating the volumes to the size and type of recipients, using e.g. turnover or number of employees. This would require data collection from other actors, and mapping the recipients, and knowing the assumptions on the transport they generate. Then there would be no need to relate to the ones actually delivering, "solving" the previously described challenges with that. However, the literature has pointed out that the ones doing the transport are the ones with the most data on the deliveries, as some recipients only receive the freight, and do not know much more. Furthermore, the ones doing the transport might be needed to get info on where that transport had started, either way.

To give potential for comparing situations over time and between cities, which is noted by the planners and the literature as a challenge today, the delivery data have to be collected and processed the same way. This is solved by using an automated way to either collect data or process data. A sufficient sample would be needed to minimize sample biases and enabling data inflation. The question is what is sufficient. One carrier thinks it is the three largest logistics actors, another sees it as a barrier for sharing data themselves that there are so many actors to contact, also mentioned by planner.

Combining data sources is also expressed as useful in order to obtain data, e.g. combining data from toll stations and the carriers to create a data set on number of vehicles and units/packages across time and location.

A planner also mentioned how many in the service sector, all with access to car through work, have to write digital/electronic driving diary/logbook (kjøredagbok), including info on: "where do they start, where do they drive, how many trips a day, and which route do they choose, this they have exact overview of" [54]. The service industry is not investigated specifically in this study, but it proposes an interesting idea for further work. However, as for other data of this sort, there are privacy issues to solve: "this is very confidential data, so they cannot just give it to anyone" [55].

4.4 What opportunities does carrier delivery data provide for these analyses?

4.4.1 Information in the delivery data sets

Data sets provided by the carriers were used to address this research question. The findings of the data sets are in line with Hovi et al. (2016) showing that the data base content among carriers vary, but can give information into transport data that can be used to complete available freight data and to verify transport models. Also in line with existing research, the carriers expressed that their systems can be adapted to include more data if it is asked for. The data sets have been examined in Excel, and the following is identified about the data:

- The delivery data for all carriers include a **timestamp** for the delivery. The format is however varying. One of the carriers do not have the specific data, only the day of the week, and no info on week number in the data.

[54] "hvor starter de, hvor kjører de, hvor mange turer om dagen og hvilken rute velger de, det har de nøyaktig oversikt over"
[55] "det er veldig taushetsbelagt data, så de kan ikke bare gi det ut til hvem som helst"

- Only one data set include explicit data on the **stop times**. One of the grocery carriers have data on actual stop times in minutes included.This is relevant to link to the location and time of the delivery.
- The logistics carriers and construction carrier have data on the **weight** of the deliveries. Some have both the freight calculated (fraktberegnet) weight and the weight, and some only the weight.
- All carriers except for one logistics carrier have **volumes** in their data set. The format is however varying, with some having cubic centimetres and some cubic metres. However, some of the deliveries do not have volume. But all deliveries (among those carriers who have weight) have the weight of the deliveries.
- Two of the logistics carriers and the construction sector have **quantities** included, with the units (kolli). These are the data sets where the deliveries are given as sendings.
- Some carriers within all sectors have **addresses** in their data sets. However, not all. Only one carrier have standardized addresses, and this is the only planner that plans on addresses. The rest plans on postal code/other geographical areas, which is reflected in addresses that are misspelled or spelled differently.The drivers might use addresses when delivering the freight, in their planning systems, but the delivery data of the carriers, do not contain these addresses.
- The data sets from all carriers except one grocery carrier include **postal code** of the delivery. Locating the deliveries based on these data sets, is therefore most possible based on postal codes. The carrier that does not have postal code in the data, plans on routes, so the routes probably cover a set of postal codes, and the destination is written in text. The carrier is a grocery carrier, with relatively rigid stops. Connecting to a database including the postal codes of the grocery stores could be possible. It would be coding the stores and location in a database one time, and then using that to locating the deliveries. Since the deliveries are more fixed than with home deliveries, it is possible that the drivers know the routes and do not rely on GPS.
- Indicating **delay**, one of the carriers have boolean data on whether the delivery was in the time window, delivered more than 30 minutes before the time window, delivered after the time window or before the time window. This can combined with the time of day give insights into at what times of day there are most delays, in terms of deliveries after the time window.
- One carrier has data on actual delivery times and planned delivery time. This is the time from when the driver has parked the car to when the delivery is marked as finished by the driver. The difference does therefore give an indication of at what location and time there is largest deviation between planned and actual delivery time, i.e. the **delay**, which can indicate where the conditions for the "50 last feet" (from car to recipient) is the worst.
- Only the grocery carriers have data on **vehicle size** included. However, in different format, one has number of pallets, the other whether the car is semi or single.
- Reflecting the planning of the carriers, the data from the grocery and construction carriers include data on their **routes**. As the routes are quite fixed over time, it could potentially be possible to code the routes to the postal codes they cover.
- In order to model the **commodity flows**, knowing which deliveries were made by the same vehicles is relevant, in order to know where the vehicle was before and after the delivery. Only one of the data sets have this info given explicitly, and the other data sets have different data that can give info on it. One of the carriers have a shift ID, of which the deliveries made with the same shift ID at the same day potentially could be assumed to be the route on one vehicle. Another data set have a transport mode ID, of which the deliveries with the same transport mode ID at the same day are done with the same vehicle, and thus can be coded as a flow. A third carrier have a PDA noted at delivery, which also identifies which vehicle was used for which deliveries on a day. A fourth carrier have a driver order ID, which work the same way. Thus, getting this information, is not easy to code automatically. The construction carrier has transport from their headquarters as well as the delivery order and driver ID, which therefore gives a

picture of the transport trough the city. However, it is not possible to know if this is the standard and would be the case for other construction carriers.

- Some of the data sets have data on the **postal code of the sender**, which would be the last postal code (origin) in the case of direct transport. For the transport that is not direct, it would be where the sending is from, but not the last stop before the delivery on the route, i.e. if the transport was grouped. In the case of the construction carrier and one of the logistics carriers, the transport chains all start at their headquarters/distribution centres. However, this info will tell about the transport being transported out of the areas.

Summarized, the data was included in the delivery data sets is seen in figure 4.3. The grocery sector is denoted as G, the logistics carriers (third-party logistics companies) are denoted as L and the construction sector C in the figure.

Sector	Carrier	Time of delivery	Stop times	Weight	Volume	Quantities	Delivery address	Delivery postal code	Delay	Delay at stops	Vehicle size	Routes	Commodity flows	Sender postal code	Sending number
G	1	x	x		x		x	x	x	x	x	x	x		
	2	x			x						x	x			
L	3	x		x		x	x	x					x		x
	4	x		x	x		x	x					x	x	
	5	x		x	x	x		x						x	x
C	6	x		x	x	x	x	x				x	x	x	

Figure 4.3: The information provided by the data sets.

Reading the figure row by row, it shows that the information to extract from the data sets varied, both within a sector and between the sectors. Reading the figure column by column, shows which information can be gained from many of the data sets, and which from only a few. The content in the data sets making the basis for the figure is presented in appendix 6.10.

Regarding information on the recipients, the logistics carriers have shared data from their B2B-segments, so the recipients are businesses. They also have B2C (business to consumer) segment, which they plan separately, so the recipients can be separated into these two groups relatively easily. The grocery carrier recipients are businesses (grocery stores and similar), and the construction sector say that they have both consumers and businesses (construction sites). For the logistics carriers, their delivery segments generate different delivery conditions, and this segregation might improve the recipient info a bit.

Figure 4.4 shows the information in these delivery data sets compared to the data needed for a tool based on the interviews, presented in subsection 4.2.3. Figure 4.4 shows that most of the needed data aspects presented in the interviews can get contributions from the delivery data, however with the limitations that have been discussed. Furthermore, the figure shows that to have the needed data for a tool, combining data from the delivery data sets might be necessary.

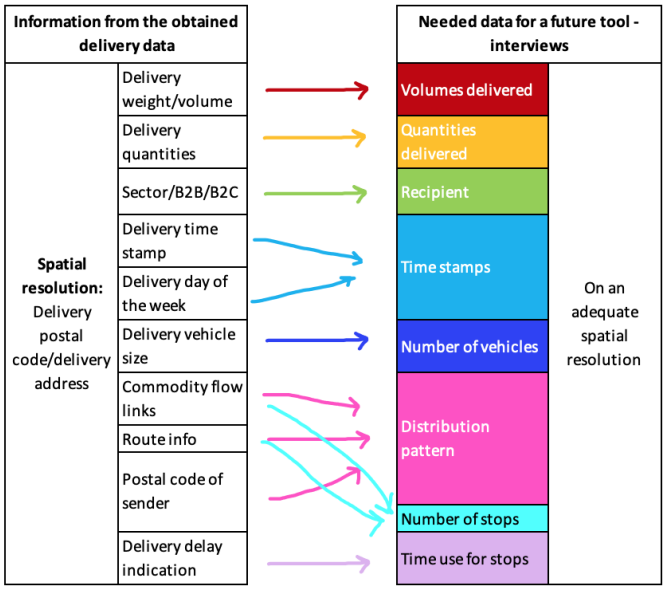

Figure 4.4: How the information provided by the data sets can contribute to the needed data for a future tool presented in subsection 4.2.3 .

An advantage with this delivery data, is that it reflects the actual deliveries and distribution, with no bias to reality in the data. A disadvantage is the fact that it is not necessarily representative, nor exhaustive, which as mentioned by the planners is difficult to achieve, due to the many involved stakeholders. And that as a result, there is a higher risk of bias if the data sharing is based on voluntarily collected data, as this might not represent the average carrier, if only the carriers with the most developed data systems/use share data. If data is collected through regulations, as discussed, it could reduce this bias.

With regards to the last-mile deliveries being part of the whole logistics chain, as discussed, the carriers do not have accurate data on this transport, in the same way as for their "last-mile" distribution. One of the grocery carriers points out how the deliveries to them are made with centrally made deals, so "the suppliers contribute to directing a lot of that traffic" [56], and the suppliers might have better data on that transport.

To have info on volume per sending etc., mentioned by the planners, data on the sending would be useful, in order to group the deliveries. Two of the logistics carriers have this data. This is related to their data being given on sending level, while the last logistics carrier has given on unit (kolli) level, and some on sending level. The data on sending level have the sending number, and the quantities as well, which are the units in that sending. The data on unit level, do therefore not have quantity. In the other cases, one sending would probably be assumed to be the total volume delivered in the commodity flow (just discussed). Whether the delivery data is given on unit or sending number, is therefore relevant to know, as it affects how the data can be used. Whether the needed data on volume per sending can be obtained is dependent on the resolution of the data. In general the resolution should be as high as possible, i.e. to cover as small deliveries as possible, defined by units. However, it is then necessary to know how to aggregate them, e.g. to number of sendings. This goes for the vehicles too. It is nice to have the deliveries, if one can aggregate it to vehicles as well. Otherwise, the sending might not be so useful in itself. On the contrary, only having the vehicles where they drove, would not give any info on smaller level.

The lacking link between freight flows and trips could be solved by establishing the link between deliveries, sendings and vehicles.

The obtained data is relevant for several of the indicators for sustainable transport indicators. This both highlights how the findings of the characteristics of an urban freight transport analysis tool are in line with the literature, and also how the data could be useful for already proposed purposes, illustrating the importance

[56] "Leverandørene er med å styre mye av den trafikken"

of collecting the data. The data does give info on when the deliveries are made, which is mentioned by the literature (Hansen et al., 2017) and the interviews, enabling analysis of time differentiated measures. In light of how surrogate measures and qualitative estimations are highly used for the planning of urban freight transport now, delivery data in the type of these carriers have potential for reducing the need for these.

Therefore, what this data can give information on is:

- Where are the deliveries happening? Easiest in what postal code, possibly at what address.
- At what time of the day are the deliveries happening?
- At what day of the week are the deliveries happening?
- What is the volume and/or weight at the different times and locations?
- Which sector category is the most prominent in different areas?
- What number of trips are attracted in different places?

4.4.2 Contribution to gaining benefits

If this delivery data can be obtained on a large scale, combined in a database and used in an analysis tool, it proposes a range of opportunities, elaborated in the following.

Combined with **projections on expected volume growth**, the information from the data sets can be used for projections on future volumes. On the possible scale, postal codes, it is not useful for the last fifty feet of deliveries.

Direct data on the transport chains is missing. However, the data can be used to locate deliveries, and then **routes be estimated**, using assumptions on fastest or shortest route between the deliveries. The time stamps on the deliveries are given, so the order is known. If GPS-tracking is then obtained, it could be used to verify these assumptions. It is not given in the data whether the same vehicles made the deliveries close by each other, or if the same vehicle drove several routes. It would therefore be more accurate with "all" data, but assumptions will have to be used as data on everything is not available now. In some cases, the routes can be identified ad-hoc, showing the actual routes. These can possibly be used to reveal information on the route choices from and used for assumptions on the other flows. Having the deliveries calculating routes between, and estimating the routes between based on some assumptions, can be used to **verify transport models**. It would give an **estimation for traffic performance** (trafikkarbeid og transportarbeid). Thus, it could be used to **test different scenarios**, as the planners expressed the need for. For example, vehicle fleet assumptions could be tested, e.g.if the vehicle consists of a certain share of one type of vehicle, that would give one amount of CO2-pollution, but if only one type of vehicles was allowed, the CO2 would be another amount. The vehicle fleet seems to be important to know more about for environmental and safety reasons. The obtained data set do not answer directly, but the implications of vehicle fleets could be investigated. Before obtaining tracking data is possible, it could therefore be useful to research more about the route choices, in order to improve the assumptions. Furthermore, as the time stamps are given, time differentiated measures could be tested. Thus, even if the data will not give direct info on all the needed matters, it will make the analyses more qualified, and give info. Furthermore, the transport volumes can with some assumptions be related to regional/national flows. The volumes within the city can be compared to the regional volumes into and out of the city area, and in this way be used to validate each other.

The location of the deliveries can give direct info for a **heat map showing the delivery density**, in line with that made within the Urban Puzzle project. This can indicate the needed density/capacity of unloading/loading spaces, as pointed out by a planner: "you can at least have a position, where the density of the transport is the highest or lowest, which may give an indication of where best to put load zones or city logistic depots, which is popular now, and identify the best location for transshipment from larger vehicles to smaller such as cargo bikes or smaller quadbikes etc." [57]. The carriers expressed value in such a heat map for them.

[57] "du kan i hvert fall få en posisjon, hvor tettheten av transporten er høyest eller lavest, som kanskje kan gi en indikasjon på

The delivery data says something about **trip production to different areas/locations**. Combined with land use data, it can give insight **into attraction of freight transport** different places. It will also say something about the trip number that is attracted to the different delivery zones/addresses (dependent on the resolution), as it says something about the capacity and traffic there. Seeing the attraction different places, when obtaining a relevant sample size of the deliveries, can give information on the deliveries (volume, quantity, number of total truck trips if have data or use assumptions) to an area, which can be seen in relation to the factors of that place, and be used to plan new areas or plan freight for existing areas of similar characteristics. This can be used to research causal models between the city and transport, i.e. how factors in the city can describe the transport. As described this could help deriving the transport volumes from different types of recipients, and the delivery data therefore help reach that potential.

The information that would be needed to combined with the delivery data in order to close more of the gap are a better way of grouping of the deliveries, to know what routes they have driven. Information about the previous and next delivery is also important in order to model the flows from a planning point of view. The stop times, are important as it affects the benefits a lot from a carrier point of view. From the planner point of view, also vehicle size and fuel is important. This vehicle information is not in the delivery data used by the carriers. It must therefore come from other sources. The subcontractors that these carriers use have the control of what vehicles are used.

Since the vehicle sizes are not included in the delivery data from the carriers interviewed, these data sets do not give information on whether it provides knowledge on light vehicle transport. This will be somewhere where combining data from other sources is needed for example with SSB/Autosys. This could also be the logbook used in vehicles mentioned. This is in line with combining different collection methods, as pointed out by the literature. This may be necessary, as this carrier data do not give insight into everything, and can rather be used to complement other data. The delivery data is seen to provide more available transport data, rather than traffic data, when the deliveries are not connected to the vehicle register.

This reflects the literature, and the importance of collecting data in a way that it is compatible with systems and other data available. Therefore, as the literature also points out, in line with the conditions for the carriers, solving the combination of different data is important. Integrating new data into existing, aligning that, is central. However, to integrate and combine data, knowledge about the data to be combined is required, so the aim of the data combination has to be defined, and the format of the data known. Then the data should be standardized for that, and then it can be combined. As the literature points out big data analyses such as CEP can become important.

The mass is required for qualification of freight, but not apparent in all of these data sets. Volume is important for information cost of transport, degree of utilization and calculation of number of vehicles needed (Natvig et al., 2016), and these data sets not containing full data on volume, gives a challenge for calculating the cost of transport and several of the results wanted by the planners. Therefore, finding out if carriers can collect volume, is relevant for modelling purposes.

The value of the transport also seems to be difficult to obtain, as also stated by the literature, as the carriers asked do not use that data themselves. One of the carriers were asked about a categorization of the value, and that could be possible, in contrast to value in monetary terms which several carriers expressed that they would not share. As they do not have the data due to not using them for planning deliveries, it would have to be connected from another source.

If the same type of ID was used on the transport, the freight and vehicles could be identified across reports, and it would help for the knowledge on the transport. Based on this study, there needs to be a benefit for the carriers to ensure such a system is developed.

Summarized, the insights can be shown in figure 4.5. The direct insights are the most accurate, as the more assumptions needed makes the insights less accurate.

hvor det er mest egnet å plassere lastelossesoner, eller bylogistikkdepot, som er litt i vinden nå, og finne den egnede lokaliseringen for omlasting fra større kjøretøy til mindre som lastesykkel og mindre firhjulinger osv"

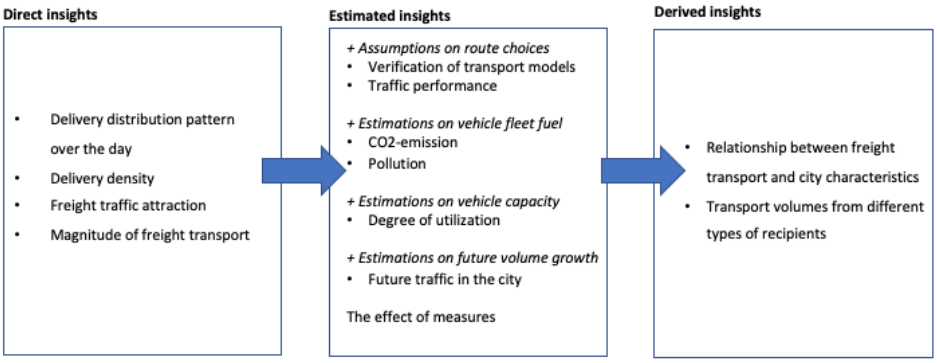

Figure 4.5: The direct, estimated and derived insights provided by the data sets.

The insights that the obtained data can be used to provide, have been compared with the desired results from an analysis tool from the interviews (see subsection 4.2.2) and the data needed for urban freight transport indicators in the literature (Patier and Routhier (2008); Fossheim et al. (2010); Halatsis et al. (2016)). The contribution of the obtained delivery data information is shown in table 4.1.

The light red colour denotes that the delivery data obtained cannot contribute to the indicator, the yellow that the delivery data can contribute combined with missing data, of which is noted by the dark red colour, and the green colour indicate that the delivery data can contribute.

The delivery data is seen to contribute directly to very few indicators. This illustrates the points made about combining data sources. When looking at what data sources to combine with, data on the routes are the most demanded, before data on the vehicle fleet and the link between deliveries and trips. Either providing data for the indicator directly or combined with other data, the delivery data is seen to contribute the most to indicators on the performance, and size and extent of the urban freight transport, as well as the emissions from the transport. The delivery data is not suited for indicators on vehicles, delivery conditions, energy use and land use.

Table 4.1: Contribution of the obtained delivery data information to the city logistics indicators based on Patier and Routhier (2008); Fossheim et al. (2010) and Halatsis et al. (2016) and the interviews.

				Lack data on				
			Obtained delivery data contribution	Route	Vehicle fleet	Delivery times	Link between deliveries and vehicles/trips	Source
UFT/CL	Loading/unloading activities	Share of illegal on-street loading/unloading in total deliveries	No					Halatsis et al., (2016)
		Number of loading/unloading in each activity [Number of deliveries and pick-ups per employee per time unit]	No					Patier and Routhier (2008)
		Loading/unloading density in a zone [Number of deliveries and pick-ups per km²]	Yes					Patier and Routhier (2008)
		Loading/unloading intensity per activity in a zone [Number of deliveries and pick-ups]	Yes					Patier and Routhier (2008)
		Loading/unloading time in a zone, per vehicle, per activity [Number of hours of on street double parking for delivery or pick-up]	No					Patier and Routhier (2008)
		Distance covered for Loading/unloading in a zone, per vehicle, per activity [Number of kilometres covered for one delivery or pick-up]	No					Patier and Routhier (2008)
	Performance	Average journey speed during peak hours	Estimated	x				Halatsis et al., (2016)
		Average speed per round including stops to make deliveries [km/hour]	Estimated	x		x		Patier and Routhier (2008)
		Average speed per round excluding stops to make deliveries [km/hour]	Estimated	x		x		Patier and Routhier (2008)
		Transport efficiency [tonnes-kilometres/vehicle-kilometres]	Estimated	x	x			Fossheim et al. (2010), int
		Rate of empty kilometres [\% of vehicle-kilometres]	Estimated	x				Fossheim et al. (2010), Halatsis et al., (2016)
		Trip distribution by day and time of the day [time intervals]	Estimated				x	Fossheim et al. (2010)
		Share of deliveries/pickups made between 07:00-10:00 hrs	Yes					Halatsis et al., (2016)
		Delays for industrial transport (næringslivets transporter)	Yes					Fossheim et al. (2010)
		Average payload per kilometre per tour, per activity, per type of vehicle [ton*km]	Estimated	x				Patier and Routhier (2008)
		Transport content [vehicle km/tonnes]	Estimated	x				Fossheim et al. (2010)
		Change in travel time	Estimated	x				Int
		Volume per sending	Yes					Int
		Change in operator cost	No					Int
		Change in accident cost	No					Int
		Effect of measures on different vehicle types	Estimated		x			Int
		Quantity of goods delivered/collected (average size of goods delivered/ collected per drop)	Yes				x	Halatsis et al., (2016)
	Delivery conditions	Stop times for deliveries (average dwell time) [minutes per delivery]	No					Fossheim et al. (2010), Patier and Routhier (2008)
	Size and extent	Freight transport performance in terms of tonnes-kilometres (transportarbeid)	Estimated	x				Fossheim et al. (2010), int
		Freight transport performance in terms of vehicle-kilometres (trafikkarbeid)	Estimated	x	x			Fossheim et al. (2010), int
		Total distance travelled on roads in urban area transporting goods by HGV, rigid lorries, and LGV	Estimated	x	x			Patier and Routhier (2008)
		Number of trips to and from an area	Yes				x	Int
		Number of vehicles involved in deliveries and pick ups per hour per type per size [Number of vehicle /h]	Estimated	x			x	Patier and Routhier (2008)
		Average distance travelled per pick up/delivery [Km per pick up or delivery]	Estimated	x				Patier and Routhier (2008)
		Number of deliveries/ collections [average number per establishment per week]	Yes					Halatsis et al., (2016)
		Journey length (average round trip length)	Estimated	x				Halatsis et al., (2016)
	Vehicles	Share of trips undertaken by ennvironmental-friendly means	No					Halatsis et al., (2016)
		Distances covered by vehicle use	No					Fossheim et al. (2010)
		Distances covered by vehicle use	No					Fossheim et al. (2010)
		Share of delivery trips made by vehicles of less than 3.5 t gvw	No					Halatsis et al., (2016)
		Share of emission free vehicles	No					Int
Environment	Energy use	Energy used by mode [GWh/year]	Nei					Fossheim et al. (2010)
	Emissions	Total emissions (local emissions and GHG emissions) by mode [tonnes/year or tonnes/year/capita]	Estimated	x	x			Fossheim et al. (2010), int
		Emissions (local and GHG) per tonnes-km and per vehicle-km [gram/km]	Estimated	x	x			Fossheim et al. (2010)
		Greenhouse gas and pollution according to the zone, the vehicle, the activity, the management (g Pollutant per km; g CO2 per km; litre of fuel per km)	Estimated	x	x			Patier and Routhier (2008)
	Land use	Average length of the first leg from platform to the delivery area	No					Patier and Routhier (2008)
		Size of land used for freight facilities [m2/capita]	No					Fossheim et al. (2010)

4.4.3 Potential for automation of delivery data extraction

Potential:

- The carriers collect a lot of data. When some carriers collect some data, it is likely that others can as well.
- This data gives a lot of information. It needs a lot of manual work, and do not close the knowledge gap, but would give valuable insights.
- If the carriers had reported data on the same format, the data extraction could happen automatically.

Barriers:

- Only the timestamp is collected by all six carriers.
- The data extraction has to be adapted manually to the varying formats of each data type.
- When the data obtained from the carriers change, the extraction system/code will have to be changed.
- Obtaining the total volume or total weight being transported will be difficult, as the grocery sector plan generally only on volume, and the others on weight.

The content of the data sets obtained were similar to the ones obtained by Tørset et al. (2020) and Moltzau (2020), while also not completely alike, indicating that the obtained data sets probably are similar to the ones used by these actors, and how the main findings are that the data sets are not common. One of the main challenges of the data sets is the fact that the addresses are not standardized in the delivery data sets, proposing time-consuming manual work in order to use them, similar to the experience of Moltzau (2020). Current data sets do therefore not give the opportunity for modelling on address level without manual work to standardize addresses. For research now, it would therefore have to be considered whether it is worth it or not to standardize addresses, based on the spatial resolution needed for the analysis. If addresses is needed, then the work have to be done by the one collecting the data. If the carriers had standardized addresses in their delivery data, this manual work would not be needed. For the carriers planning on postal code, having the exact location might not be used by them, so an incentive might be needed for including it in the data that is desired to get from them. Related to the spatial resolution on addresses, it should be considered whether the privacy issues will be a concern. Perhaps should it rather be aggregated to a cell size level, as some might now what is at different addresses, and then who deliveries there.

Regardless, processing is currently needed of the data. In the future, this processing could either be by the carrier sending excel sheets, and the processing happen on the collector's side to extract and transfer the data into a database, or the carriers could upload it into the right format to a web page or similar, and the people with access could only get access to the info there. The first solution is probably very resource demanding, based on this study and previous, if the databases/systems of the carriers are not adapted. With the time demand as today, that likely leads to the job not being done, and the information from carriers not being exploited. And if the databases have to be adapted either way, it is likely to believe that it is a more efficient process if the carriers upload the correct data, with a larger probability of the conditions for them to benefit from the data sharing to occur.

The data was not really prepared for easy extraction, and therefore resource demanding to process. However, the information the delivery data sets can give, is useful. The condition for the use of carrier data as obtained, is that the databases give info on only the area that data was collected from, as pointed out by Hovi et al. (2016), which limits what the data can be used for. However, as the researcher in the interview and literature points out, case specific evaluations of urban freight transport is needed, and good information on the city therefore seems to be more important than having national estimates of urban freight transport. On the other hand, the current data sets due to lack of standardization, do not enable comparisons. But, as discussed, standardizing the data wanted from the carriers can help with this.

4.5 Added knowledge from the interviews

In addition to the findings discussed in the research questions, the interviews provided more knowledge on urban freight in general. These findings are not directly related to the research questions, but valuable for the subject of the study.

4.5.1 Planning of the carriers' transport

The carriers were asked about their planning of the transport as part of understanding their background. The planning can be seen in relation to the challenges.

In general, "known" patterns were found. The different types of carriers and sectors have different planning and transport.

From the planning among the carriers, it is clear that

- All carriers have relatively fixed routes that have been established over time, adjusting the demand slightly from day to day, adding or removing some vehicles. Starting and ending at their company's location.
- However, the logistic carriers distributing to people's homes have larger variation in the transport than the grocery distributors.
- Grocery distributors distributing to their own stores have higher degree of control of delivery conditions.
- Some carriers use tools to decide the order of customers and packing of the vehicle, others the drivers' knowledge.
- Rather than what is being transported, the recipients play a large part in determining the transport.
- One of the carriers plan on address level, the other on postal code level or using established routes in areas.

One interesting observation is from a carrier delivering to their own grocery stores. With regards to the relation between the stores receiving the deliveries and the carriers, they say: "We are perhaps more in dialogue with the shops than other companies are. There is no purpose in us sub-optimizing at our end if that leads to higher costs in the other end, it's from the same business, so we'd shoot ourselves in the foot" [58]. This shows how the carrier and receivers being in the same company, makes the understanding of the freight chain more whole. I.e. that they have more understanding for each others role. This indicates that more cooperation between actors and getting more ownership of the transactions between the actors, can enable less sub-optimized solutions, as are seen today with e.g. small time windows and in-efficient routes, which is a larger problem for the other carriers interviewed than this one. The carrier further describes that this is related to their stores being subject to a service level agreement that sets out the conditions and frequency of deliveries: "All our shops are bound by a set of conditions that defines how we deliver to them, among others there is a set of rules about frequency to the shop, that is how many deliveries they are entitled to from each product are, and what triggers the next increase in frequency" [59]. This shows how neither player has full freedom, and that the transport is rather decided by a bigger perspective. This can draw inspiration to the need for collaboration and related to how collaborating for an analysis tool can be helpful.

4.5.2 Analysis tools and existing challenges

Several challenges for working with urban freight analyses in existing analysis tools (NGM and RTM) are discussed by the planners. Among the challenges mentioned by the public and private planners is how the zones in NGM are too large for working securely in cities, with the implication that the distribution on road links

[58] "Vi er kanskje mer i dialog med butikkene våre enn det andre firmaer er. Det har ikke noen hensikt at vi sub-optimaliserer i vår ende hvis det fører til mer kostnader i andre enden, det kommer fra samme firma uansett. Da skyter vi oss selv litt i foten"

[59] "alle butikkene våre er underlagt et betingelsessett som sier noe om hvordan vi skal levere til dem, blant annet der er det et regelsett om frekvens til butikk, altså hvor mange leveranser de har krav på ut fra hvert enkelt vareområde, og hva som utløser neste frekvensøkning"

is not exact or precise, as NGM is a national model, developed for another purpose than city logistics. The planners stress the need for higher spatial resolution than current urban analysis tools enable. However, data on a higher resolution is not available, other than from carriers: "NGM stops at zone level. For example, in Oslo there are 11-12 different zones, so there is quite a rough resolution. At that resolution level it is possible to get data. But, when you are down to deliver something at Lademoen for example, then you basically do not have data at the level of detail that is easily accessible, so you would have to get it from those who own the data" [60]. The planner does in this way express how obtaining data from the data owners would be required in order to improve the planning process.

Furthermore, the lack of integration between the freight model and passenger transport models for socio-economic analyses is seen as a challenge. The benefits calculated in socio-economic analyses are important for whether projects are realized or not. Currently, the consequence is that the decisions are taken on a faulty basis, as the value of saved time is larger for freight than passenger traffic. Related to these socio-economic analyses is also the fact that NGM currently does not handle capacity problems, and the potential benefits of reduced queues of measures is not captured. The consequence of this, is potentially improper prioritization of projects and reporting lower benefits in urban projects compared to more rural projects with less capacity problems. Another challenge is the lack of variation over day in current tools. Both the public planners and the researcher mentioned that this results in the lack of possibility to simulate the expected effects of measures in cities. The consequence of the latter is that new measures must be tested in real life, which is expensive and inefficient, making new measures risky to implement. Regarding the lack of possibility to do evaluations of measures, a public planner expressed: "what can the effect of measures be? I think that is quite important - and I think that is one of the reasons why you know so little about freight transport, because you cannot say what the effect will be, if you do something. You do not know exactly how it is, and not how it will be – so how do you then do something?" [61]. This illustrates that lack of knowledge leads to uninformed decision making.

The public and private sector planners agree on these challenges, as users of the same tools (NGM and RTM). Neither the policy maker nor the researcher was users of such tools. However, they use the results from the tools, and are therefore indirectly implicated, even if they can't speak directly towards the use of the tools.

A picture of the challenges of the carriers indicates what is most crucial for a tool to contribute to improve the situation for them in order for them to benefit from sharing data to a tool. The carriers mentioned a range of traffic related challenges for their distribution:

- **Strategic demands about car-free city centres** are mentioned by a logistics carrier, as it makes it difficult for them to distribute, such as the next point.
- **Traffic regulations as one-way roads, access denied etc.** is mentioned as a challenge by both the grocery and logistics carriers. They experience that this challenge leads to ineffective routes between their stops.
- **Insufficient loading zones, as they are too few and too small** is a challenge mentioned by the grocery and logistics carriers. Their drivers have to drive extra rounds hoping that the loading zone is free the next time. This creates queue and more heavy vehicles in the city.
- **Time windows for delivery** is mentioned as a challenge by the grocery and logistics carriers. This contributes to in-efficient logistics/routes, and thus need for extra vehicles, leading to more vehicles in the network, more km driven, and lack of flexibility to exploit the cars well, as well as extra fuel use and time use for the drivers, increasing operating costs.
- **Narrow streets and alleys** is mentioned by the logistics and construction carriers. They experience that this has implications for backing up, reducing safety.

[60] "NGM stopper på sonenivå. F.eks. i Oslo er 11-12 forskjellige soner, så det er ganske grov oppløsning. På det oppløsningsnivået går det an å få data. Men, når du er nede på å levere noe på Lademoen f.eks., da har du i utgangspunktet ikke data på det detaljnivået som er lett tilgjengelig, så det må man gjerne få av de som eier"

[61] "Hva kan effekten av tiltak være? Det tror jeg er ganske viktig – og det tror jeg er en av grunnene til at man vet så lite om godstransport, for man kan ikke si noe om hva effekten hvis man gjør noe blir. Ikke vet man helt hvordan det er, og ikke hvordan det blir – hvordan skal man da gjøre noe?"

- **Freight deliveries on the street** is mentioned by the grocery and logistics carriers. This creates conflicts with other road users, reducing safety.
- **In-adequate reception points (varemottak)** is mentioned by the grocery carriers, as delivery takes long time, and it affects the health and safety at work for the drivers.
- **Demands about environmentally friendly vehicles only** is also mentioned by a logistics carrier, making their distribution more difficult, and especially due to lack of willingness to pay for it among their customers.
- **Demands about smaller vehicles specifically**, mentioned by the grocery carriers, as they carry a lot of volume demanding material for temperature handling. They also believe it will lead to more trips.
- **A third-part owning the road network and large parts of the delivery conditions** is mentioned as a challenge by a grocery carrier, as it becomes time-consuming and challenging to facilitate good deliveries, and it affects the health and safety at work for the drivers.

The carrier within the construction sector mentioned only one traffic related challenge. This can be explained by how several of the challenges mentioned by others, do not occur in the construction sector. Delivering to construction sites, the carrier explained that the customer is in charge of providing sufficient un-loading space and facilities. Looking for parking at the street, is therefore less relevant for them. Furthermore, the customers in residential areas usually explain potential difficulties with deliveries beforehand, so it can be planned for.

One of the important challenges is the time windows. One carrier is quoted: "We can have shipments for delivery, one between 10 and 11, the next between 11 and 12, and some between 10:30 and 11:30, which means we don't have the flexibility to utlize the cars in a good way. This is a challenge in city logistics, as it contributes to generating more city traffic. Don't think the decision makers considers this, they don't know the system well enough" [62] Another carrier is quoted: "it locks our logistics so it becomes ineffective." [63]. This illustrates how the carrier experiences the planners/decision makers not having adequate knowledge on their distribution.

It is clear that these challenges contribute to in-efficiency in the urban freight. More kilometres are being driven, and more vehicles are in the road network. One of the carriers, talking about the implications of in-adequate conditions for urban freight in Trondheim, is quoted: "I feel they don't consider that to have a lively city centre we need products and services supplied to those who live, work and have shops in town. This is not only carriers, but also plumbers, electricians, chimney sweepers etc" [64]. and "if it was better organized for accessibility through the street use plan, and with regards to delivery points, loading ramps, and loading zones, the number of vans in the centre of Trondheim would be reduced with several percentages. This could give high environmental gain, by increasing the efficiency of each car by 25%, which I don't think is a problem. It would in itself have environmental benefits, and fewer vans disturbing other road users in the centre, be that buses, pedestrians or cyclists" [65]. This is a further illustration on the lack of knowledge the carriers experience among the other actors.

Regarding the unintended consequences for carriers, the challenges show that most are negative. However, there is also an example mentioned by a carrier on how the tunnel under Trondheim helped improve their logistics: "we had some deliveries in the morning on each side of town, which we never managed to identify a good route for. Now we actually deliver those two, at each side of the city, on the same car, because driving

[62] "Vi kan ha sendinger som skal leveres, en mellom 10 og 11, neste mellom 11 og 12 og noen mellom 10.30 og 11. 30 – som gjør at vi ikke har den fleksibiliteten som gjør at vi får utnyttet bilene på en god måte. Det er en utfordring i bylogistikk, for det er med å generere mer bytrafikk. Tror ikke beslutningstakere tenker over det, de kjenner nok ikke det systemet godt nok."

[63] "det låser logistikken vår så den ikke blir effektiv"

[64] "Føler at de ikke tenker over at for å få et levende bysentrum, må vi ha varer og tjenester som tilbys de som bor, jobber og har butikker i byen. Det gjelder ikke bare transportører, også rørleggere, elektrikere, feier osv. Det er skapt en del begrensninger trafikkmessig i bysonene som gjør at det er svært vanskelig å drive forretning"

[65] "Dersom det hadde vært bedre tilrettelagt både for fremkommelighet gjennom gatebruksplanen og mtp. leveringspunkter, lasteramper og lastesoner, ville antallet lastebiler i Trondheim sentrum blitt redusert med mange prosent. Det kunne gitt en voldsom miljøgevinst, ved å få opp effektiviteten på hver bil med 25%, som jeg tror ikke er noe problem. Det vil i seg selv gi miljøeffekt, og færre lastebiler som forstyrrer andre trafikanter i Trondheim sentrum, om det er busser, fotgjengere eller syklister"

through the tunnel under the city is fast" [66]. This indicates how not knowing where the commodity flows are, also makes it difficult to predict and account for potential positive consequences.

These are the challenges that the carriers meet today. It is clear that

- The carriers experience unintended effects from restrictions probably meant to target passenger traffic.
- The carriers experience a lack of collaborating fora - need somewhere to raise concerns and interact with the municipalities.
- The carriers experience that the customers do not see how them restricting time for deliveries makes the freight transport in-efficient.
- The carriers believe that more efficient urban freight transport can reduce the negative implications of freight vehicles in the city environment, in terms of less vehicles and fewer km driven.

A thorough understanding of these challenges and the carrier perspective on the transport, is important in order to avoid potential conflicting goals regarding the tool. If the planners promise the carriers benefits from sharing data in order to obtain it, but then use the information to implement more restrictions/orders, without the carriers experiencing that this improves their situation, it could threaten the successfullness of an analysis tool.

4.5.3 Knowledge gap

The public and private planners mentioned several specific knowledge gaps within the urban freight transport, as a result of lack of data, and the current data collection processes. The researcher and policy maker, not being users of the tools, did not mention any specific data gaps, and rather pointed out overarching challenges related to the planners' data gaps, and strategic perspectives. The specific data gaps mentioned are:

- Do not know when the freight is transported, which is useful related to quantifying effect of delay and rush hours.
- It is difficult to verify estimations of freight from volumes onto vehicles.
- A large lack of knowledge due to lack of data on transport with vans. Therefore, there is lack of data on a large share of the traffic, as there are lots of vans in urban distribution. This is related to the traffic counts counting on length, and vans being shorter than 5.6m.
- Lack of data on distribution routes. Have sufficient info on direct transport, but not on routes. Do not know where they have been or number of stops.
- Lack of data (knowledge) on stops - the quantity and time use. Do not capture e.g. the effect of making the "50 last feet" (from car to recipient) more efficient.
- Lack of knowledge (data) on the vehicle fleet driving in the cities - quantity, type, size.
- Lack of knowledge on the actors serving the distribution in cities, which also varies over time (e.g. construction sector). Do not know who to ask for data, or its representativeness.
- Lack of knowledge on delivery terms for the transport. The public planners therefore do not know how setting demands for deliveries in the city (such as time restrictions) will affect the involved actors. The delivery terms are difficult to acquire due to confidentiality.
- Lack of knowledge/data on the recipients of freight. Can know the freight type, but a lot of freight types is used by different recipient types.
- Lack of data/knowledge on expected traffic generation/production from different areas/functions.

[66] "Vi hadde noen leveranser på morgenen på hver side av byen, som vi aldri helt fikk landet en god rute på. (...) Nå leverer vi faktisk de to, som ligger på hver side av byen, på samme bil, på grunn av at det går fort å kjøre tunellen under byen"

5 Conclusion

The objective of this study was to investigate potentials, barriers and a method for obtaining urban freight transport data. This has been done through two sets of interviews. One set of interviews included 11 planners, one researcher and one policy maker based in Trondheim/Oslo on their analysis and data needs within urban freight transport. The second set included interviews with six carriers based in Trondheim on their willingness to share data and data use. Furthermore, a data analysis of delivery data sets obtained from the same carriers was conducted, in order to investigate the insights this data can give, and the potential for automated extraction of data.

The analysis on how the collection of urban freight data from carriers can contribute to more sustainable city logistics, has in this study been broken down into

- potential benefits for the involved actors;
- what aspects achieving these benefits would require of an analysis tool;
- how transport data could be obtained from freight carriers and how it should be collected in order to benefit the analysis;
- how existing delivery data sets from carriers contribute to cover the data needs for an analysis tool.

Potential benefits of urban freight transport analysis for more sustainable city logistics
From the interviews, urban freight transport analysis is expected to contribute to informed city logistics planning which can reduce the negative externalities from urban freight transport. This is a common goal for all these actors, and thus also a common benefit. The ability to evaluate measures would improve the planners' understanding of today's freight situation, contributing to freight being considered to a larger degree in city planning. This would benefit both the planners and the carriers, who could experience larger predictability and less unintended consequences for their operation. An analysis tool for the urban freight transport, is also addressed to be valuable to help predict future traffic volumes and traffic situation, as well as understanding and meeting future trends for the urban freight transport. Providing a data-driven understanding and evaluating measures, is also identified as benefitting policy makers, who would get a common factual basis for decision making. Furthermore, an analysis tool that is using data from carriers, and provides benefits for the carriers in terms of better use of the infrastructure and land area, can contribute to improve the interaction between public authorities and the carriers, as they to a larger degree will understand each other's situation and cooperate towards common goals. If the benefits for the carriers in terms of reduced operational costs of measures can be quantified in the analysis tool, it would benefit the policy makers, who wants to communicate benefits to the private actors in order to stimulate innovation. The direct benefits for the carriers from an analysis tool is found to be dependent on how rigid their transport operations are, and who decides the terms for the distribution. The benefits for the carriers seem to be knowledge on the holistic picture of freight transport in an urban area, so that they can adapt their tactical/strategic planning, in order to achieve more efficient and reliable distribution. The increased focus that numerical basis on the urban freight transport will give is also valuable for the carriers, as their situation is easier to understand and act upon.

Requirements to improve current freight transport analysis
However, the degree of release of these benefits that an analysis tool can contribute to, depends on the purpose and characteristics of the tool. An urban freight analysis tool should therefore as much as possible help to meet those needs. According to this study, the purpose of the tool should be to provide knowledge regarding measures to implement and to identify and convey benefits/commercial interests to private actors which may stimulate innovation. The analysis tool should therefore also provide a common factual basis and new knowledge to all actors involved. The measures that should be possible to evaluate in such a tool, are the ones reducing the challenges for the carriers and inhabitants of the city the most. Based on this, the following are needed to improve compared to current existing freight analysis tools: aspects of high spatial and temporal resolution, ability to model a vehicle fleet reflecting the innovations in vehicles seen today, ability to capture the heterogeneity of urban freight transport, inclusion of capacity of road links and enabling interaction with

other tools. All of these aspects will be trade-offs between a high detail level and the resources required to obtain and process the data. A thorough understanding of the purpose of the tool is therefore important before developing, in order to create something that actually benefits the urban freight value chain.

How data can and should from the carriers be obtained in order to enable these analyses
A thorough understanding of the purpose of the analysis tool, is also key for collecting carrier data. This study has also shown that sharing data must benefit the carriers in terms of better city planning, related to how they demand a defined plan and purpose for the data sharing, as well as a clear framework and boundaries for the use of the data. Furthermore, in order to obtain carrier data on a large scale, as with other data, anonymization and data security has to be ensured, as well as complying with market considerations. The data also has to be obtained from "all" carriers, due both to representativeness of the data as well as restricting the potential for identifying the various carries providing data. Further, the data sharing process must demand little extra resources from the carriers, as their internal data collection already is sufficient for their daily operations. A clearly defined purpose of the data sharing is one of the requirements from the carriers should they contribute. Both the planners and carriers indicate that the data used for analysis purposes should be collected in a way that minimizes the resources needed, including data updating, and in a way that is common over time and space, enabling comparisons. The literature and trends for data use among the carrier points to the fact that this data collecting/extraction and processing should be done using automated methods. The literature proposes a conflicting view on whether carrier data should be collected through regulation or on voluntary basis. Regardless, this study indicates that the chosen method should contribute to collecting as representative data as possible and creating mutual benefits from the data.

The opportunities carrier delivery data provide for these analyses
In this study, samples of carrier delivery data were possible to obtain, and found to have the potential to contribute to a lot of information on the urban freight transport that is useful in an analysis tool. The direct insights that the delivery data has shown to give includes the delivery distribution pattern over the day, delivery density, freight traffic attraction and the magnitude of deliveries. The delivery data can be used to extract this information automatically on address level, given that either the data is obtained with standardized addresses or the addresses in the current delivery data sets are manually cleaned. Reflecting how most of the carriers interviewed plan their transport on postal codes, automated extraction of the data providing this information is easier. Whether this is resources that should be used or not does however tie to the discussion on the optimal/appropriate level of spatial resolution. However, considering urban freight transport indicators from the literature and desired results from an analysis tool, the delivery data is of limited usefulness. This confirms the literature on the fact that combination of data sources is needed. Information to combine with the delivery data, is data on routes, the vehicle fleet and the link between deliveries and trips. The delivery data can alone or in combination with this information, contribute to indicators on performance, size and extent of the urban freight transport, as well as emissions from the transport. The study has shown that these are the most important aspects for the planners to have better analysis tools for.

To summarize, collection and analysis of urban freight data from carriers can contribute to more sustainable city logistics in the sense that the data-driven understanding and higher degree of cooperation between different actors within city logistics have the potential of reducing negative externalities from urban freight transport and improving the distribution for the carriers, leading to more sustainable city logistics in terms of less environmental impacts, more economic distribution and better health for inhabitants. This data-driven understanding is important in a complex and conflict-filled landscape of city logistics. Better understanding of urban freight transport today and in the future, can contribute to a more robust transport system, which is needed in the light of uncertainty from climate changes and other developments. The realization of the benefits is, to a high degree, related to how well the tool can contribute to an understanding of the situation for those planning and executing the transport. Delivery data sets from the carriers have, through this study, been possible to obtain, and even with complying with the identified terms for sharing data, promise a lot of insights that are not currently available. However, the study has also shown that this delivery data must be combined with other data to be useful, especially data on the vehicle fleet.

Based on the pilot, the carriers are willing to share data on some terms. It remains to be seen if other sectors are interested in the same, but there is no reason that they should not.

5.1 Recommendations for further work

Further research on automated extraction of the delivery data
Through this study, delivery data sets have been obtained. Due to the limited time and resources available, the data analysis was limited to Excel. The literature and findings of this study highlight the need and potential of automated data extraction, and further research on how to extract data from existing data and combining it to a database is therefore useful. This could help gaining a better understanding of how the data can contribute to analyses, and how the data should be obtained in order to minimize resources needed for cleaning and processing this delivery data.

Research on obtaining other types of needed carrier data
The study has shown that while the obtained delivery data do give valuable insights, combining this data with other types of carrier data will enable the delivery data to provide information for more urban freight transport analyses and indicators. Specifically has data on routes, the vehicle fleet and the link between sendings and trips been highlighted. In order to get data on routes, a more detailed study into how tracking data could be obtained would be useful. The study has indicated that both the tracking data and data on vehicle fleet could be more appropriate to ask for from the carriers owning the vehicle fleets. Gaining more insights into the vehicle sizes, for the carrier data to contribute to close the gap on information on light vehicles and the increasingly heterogeneous urban freight vehicle fleet, is important.

Investigating the available data and data use among other urban freight transport actors
Related to the point about obtaining other types of required data, is investigating what data is available among the different actors. This study has shown the potential that obtaining delivery data from third-party logistics operators, grocery carriers and construction carriers give. This study has not focused on the service industry. As this makes up a considerable share of the urban freight transport, it would be relevant to investigate how they are in relation to the findings in this study. Researching how the data among the other urban freight actors such as retail, renovation, hotel, restaurant and catering and delivery services, could give insights into the potential of including this transport in analyses. The interviewees have indicated that home services and renovation might be the most obvious to include. Other actors mentioned during the interviews are the freight owners, such as actors that have their own transport, and do not use logistics carriers etc., such as large freight receivers/senders. Utilizing their data, if it is useful, can be an approach to reduce the need for data from carriers, and will in any case affect who should be asked for data. With regards to the service transport, it can be worth researching obtaining and the potential from data in the digital/electronic driving diary/logbook that one of the planners mentioned. Since this study has found that the way the carrier plan their transport affects the data they have and value they see in analyses, getting an improved understanding on how these different urban freight sectors plan their transport might help to know who and how to ask for data and how to incorporate their data.

Researching the B2C segment of logistic transport
The future urban freight transport is expected by both carriers and the planners/researcher to contain more e-commerce and home deliveries. With regards to the commodity flows this creates, it is relevant as the carrier notes, with the distribution ways for B2C. Being easier to optimize for the carriers, with fewer end points, this can provide more accurate modelling. As B2C-data was not obtained in this study, it is not known how the data format for this flow is. Acquiring this data could be useful to investigate, in order to research integration of B2B and B2C flows in the same tool. However, this points out the complexity of the urban freight actors/sectors.

Generalization of this study's findings
This study has been done on a qualitative basis with limited time and resources. As the study has shown that a thorough understanding of the purpose of a tool and each other goals and needs is essential in order for cooperation and a tool to contribute to more sustainable city logistics, generalization of the findings of this

study could be useful. This entails researching what a larger sample of planners, researchers and policy makers and carriers think is important for them. This could also beneficially be generalized in terms of geography, as the needs are seen to be dependent on the current challenges of a city.

References

Aifandopoulou, D. G. and Xenou, E. (2019), 'Topic guide sustainable urban logistics planning', https://www.eltis.org/sites/default/files/sustainable_urban_logistics_planning_0.pdf. Developed in the framework of the NOVELOG project, being funded by the European Union's Horizon 2020 Research and Innovation programme. (Read 06.06.2021).

Allen, J. and Browne, M. (2016), 'Success factors of past initiatives and the role of public-private cooperation', https://www.citylab.soton.ac.uk/deliverables/D2_3.pdf. CITYLAB Deliverable 2.3. Part of European Union's Horizon 2020 research and innovation programme. (Read 25.03.2021).

Allen, J., Browne, M. and Cherret, T. (2012), 'Survey techniques in urban freight transport studies', https://www.tandfonline.com/doi/pdf/10.1080/01441647.2012.665949?needAccess=true. Transport Reviews, Vol. 32, No. 3, 287– 311, May 2012. (Read 27.11.2020).

Andersen, J. (2020), 'Kan raske leveranser for netthandel også være effektive? analyse av porterbuddys hjemleveringsløsning i stor-oslo', https://www.toi.no/getfile.php?mmfileid=54407. TØI-rapport 1796/2020. (Read 28.05.2021).

Basberg, M. (2019), 'Nytten av norsulp verksted - og hva trenger vi av kunnskap?', https://www.vegvesen.no/_attachment/3060063/binary/1381078?fast_title=Nytten+av+NORSULP+verksted+og+hva+trenger+vi+av+kunnskap+-+Mari+Basberg.pdf. Presented on NORSULP sluttkonferanse 27.11.2019 (Read 13.12.2020).

Bjørgen, A. (2020), *Perspectives on the future of freight transport*, Sintef. Lecture held in the course Sustainability Issues in Transport at NTNU 13.11.2020.

Browne, M. and Allen, J. (2006*a*), 'Bestufs best practice in data collection, modeling approaches, and application fields for urban commercial transport models. deliverable d3.1', http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_II_results_datacollection/BESTUFS_II_data_collection_synthesis_report.pdf. www.bestufs.net (Read 10.11.2020).

Browne, M. and Allen, J. (2006*b*), 'Report on urban freight data collection in the uk', http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_II_results_datacollection/BESTUFS_II_data_collection_report_UK.pdf. BESTUFS WP 3.1. (Read 27.11.2020).

Browne, M. and Goodchild, A. V. (2013), 'Modeling approaches to address urban freight's challenges a comparison of the united states and europe', https://www.fondazioneitl.org/wp-content/uploads/City-Logistics-Research-A-Transatlantic-Perspective.pdf. Appendix A, City Logistics Research A Transatlantic Perspective - Summary of the First EU-U.S. Transportation Research Symposium (Read 10.11.2020).

Campagna, A., Stathacopoulos, A., Persia, L. and Xenou, E. (2007), 'Data collection framework for understanding uft within city logistics solutions'. 3rd Conference on Sustainable Urban Mobility, 3rd CSUM 2016, 26 – 27 May 2016, Volos, Greece. (Read 08.11.2020).

Caspersen, E. (2020), 'Kan konsumenter bidra til bærekraftig bylogistikk?', https://www.vegvesen.no/_attachment/3103202/binary/1386243?fast_title=Kan+konsumenter+bidra+til+b%C3%A6rekraftig+bylogistikk+-+Elise+Caspersen.pdf. Presented on Fagdag om bærekraftig bylogistikk 24.11.2020 (Read 13.12.2020).

Debauche, W. (2008), 'Issue 1. policy : Why local decision makers are so reluctant to urban freight modelling and data collection?', http://www.bestufs.net/download/Roundtables/4th_Roundtable_Rome08/Minutes_Roundtable_Rome_2008.pdf. Minutes of the BESTUFS II, WP3, 4th Roundtable, Roma (Read 10.11.2020).

Denstadli, J. M., Vågane, L. and Wethal, A. W. (2014), 'Håndverkertransporter i by: Volum- og strukturestimater', https://www.toi.no/getfile.php?mmfileid=39235. TØI rapport 1336/2014. (Read 13.12.2020).

Eidem, M. and Johannessen (2019), 'Schibsted vil komme amazon i forkjøpet – lanserer tjeneste for hjemlevering fra nettbutikker', https://www.dn.no/medier/netthandel/schibsted/logistikk/schibsted-vil-komme-amazon-i-forkjopet-lanserer-tjeneste-for-hjemlevering-fra-nettbutikker/2-1-672513. DN.no (Read 13.12.2020).

Eidhammer, O. (2021), 'Indikatorer for bylogistikk', https://www.toi.no/getfile.php?mmfileid=55326. TØI-rapport 1815/2021. (Read 26.02.2021).

European Commission (2013), 'Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions', https://ec.europa.eu/transport/sites/transport/files/themes/urban/doc/ump/com%282013%29913_en.pdf. COM(2013) 913 final (Read 11.11.2020).

Finstad (2021), 'Helthjem sitter på med kolonial: – nå får vi fylt opp bilene', https://www.dn.no/handel/netthandel/kolonialno/helthjem/helthjem-sitter-pa-med-kolonial-na-far-vi-fylt-opp-bilene/2-1-949418. DN.no (Read 25.01.2021).

Flygansvær, B. (2020), 'Logma: Fremtiden har ankommet', https://www.tungt-logistikk.no/article/view/731417/logma_fremtiden_har_ankommet. (Read 09.12.2020).

Fossheim, K., Andersen, J., Eidhammer, O. and Bjørgen, A. (2010), 'Indikatorer for miljøvennlig logistikk', https://www.toi.no/getfile.php?mmfileid=14441. TØI-rapport 1072/2010. (Read 24.03.2021).

Fossheim, K., Andersen, J., Eidhammer, O. and Bjørgen, A. (2017), 'Faglig grunnlag for bylogistikkplaner', https://www.toi.no/getfile.php/1346046-1508834143/mmarkiv/1588-2017.pdf. TØI rapport 1588/2017 (Read 08.10.2020).

Frøberg, A. (2020), 'Stor økning i netthandelen', https://www.ssb.no/varehandel-og-tjenesteyting/artikler-og-publikasjoner/mer-netthandel-mindre-butikkhandel. (Read 09.12.2020).

Førde, H. (2020), 'Pantesjefen måtte sloss med koronaeffekten i sommer', https://www.tungt-logistikk.no/article/view/738184/pantesjefen_matte_sloss_med_koronaeffekten_i_sommer. (Read 09.12.2020).

Halatsis, A., Gagatsi, E., Chrysochoou, E., Stathacopoulos, A. and Xenou, E. (2016), 'New cooperative business models and guidance for sustainable city logistics - d2.3 "understanding cities" tool', https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5aa96838e&appId=PPGMS. Developed in the framework of the NOVELOG project, being funded by the European Union's Horizon 2020 Research and Innovation programme. (Read 06.06.2021).

Hansen, W., Madslien, A., Grønland, S. E., Hovi, I. B. and de Jong, G. (2017), 'Vurdering av det nasjonale modellsystemet for godstransport', https://www.toi.no/getfile.php?mmfileid=44592. TØI rapport 1559/2017. (Read 11.12.2020).

Harrington, T. S., Singh, J. S., Kumar, M. and Wohlrab, J. (2016), 'Identifying design criteria for urban system 'last-mile' solutions – a multi-stakeholder perspective', https://www.tandfonline.com/doi/pdf/10.1080/09537287.2016.1147099?needAccess=true. Production Planning & Control 27 (6): 456–476. (Read 16.11.2020).

Hjelkrem, O. A. and Bjørgen, A. (2017), 'Urban puzzle pilot prosjektpresentasjon med kommentarer'. Powerpoint with comments received from the authors over e-mail (Received 01.03.2021).

Holme, I. M. and Solvang, B. K. (1996), 'Metodevalg og metodebruk'. Access acquired through NTNU Oria and Nasjonalbiblioteket.

Hovi, I. B., Caspersen, E. and Ørving, T. (2017), 'Bruk av vegvesenets databaser for analyser av godstransport i by', https://www.toi.no/getfile.php/1345365-1497267723/Publikasjoner/TTØI rapport 1568/2017 (Read 08.10.2020).

Hovi, I. B. and Mjøsund, C. S. (2019), 'Nye data kan gi smartere og renere lastebiltransport', https://samferdsel.toi.no/forskning/nye-data-kan-gi-smartere-og-renere-lastebiltransport-article34368-2205.html?noredirect=1. Samferdsel.no (Read 13.12.2020).

Hovi, I. B., Pinchasik, D. R., Auråen, E. and Natvig, M. K. (2016), 'Data om godstransport. dagens statistikk og nye datakilder', https://www.toi.no/getfile.php?mmfileid=43889. TØI rapport 1524/2016. (Read 11.12.2020).

Hovi, I. B., Slåttum, T. and Bø, E. (2019), 'Økonomisk kjøring gir kostnads- og miljøgevinster', https://samferdsel.toi.no/forskning/okonomisk-kjoring-gir-kostnads-og-miljogevinster-article34380-2205.html. Samferdsel.no (Read 13.12.2020).

Ivarson, H. (2019), 'To varestrømmer slås sammen i oslo', https://www.tungt-logistikk.no/article/view/731564/to_varestrommer_slas_sammen_i_oslo. (Read 10.12.2020).

Ivarson, H. (2020), 'Elskede by inntar trondheim', https://www.tungt-logistikk.no/article/view/731352/elskede_by_inntar_trondheim. (Read 10.12.2020).

Iwan, S. (2014), 'Adaptative approach to implementing good practices to support environmentally friendly urban freight transport management'. 1st International Conference Green Cities 2014 – Green Logistics for Greener Cities, (Read 08.11.2020).

Jacobsen (2005), 'Kvalitative intervjuer og observasjon', https://www.uio.no/studier/emner/jus/afin/FINF4002/v12/Metode.kval.intervjuer.pdf. (Read 10.12.2020).

Jensen, S. A. (2019), 'Bærekraftig bylogistikk - veileder for kommuner', https://www.toi.no/getfile.php/1351777-1575390853/Sidsel Presented on NORSULP-conference 27. November 2019 (Read 09.10.2020).

Karlsson, H. and Bjørgen, A. (2019), 'Logistikk som del av byplanlegging - hvordan ta det neste steget?', https://www.toi.no/getfile.php/1351798-1575391096/Hampus%20Karlsson.pdf. Part of NORSULP-conferance 27.10.2019. (Read 09.10.2020).

Kijewska, K., Malecki, K. and Iwan, S. (2016), 'Analysis of data needs and having for the integrated urban freight transport management system'. In International Conference on Transport Systems Telematics, 135–148. Cham: Springer. (Read 08.11.2020).

Kommunal- og moderniseringsdepartementet (2018), 'Regionale utviklingstrekk 2018', https://www.regjeringen.no/contentassets/59c12ad48f604486926d605f1680871e/no/pdfs/regionale-utviklingstrekk-2018.pdf. (Read 02.12.2020).

Langeland, O. (2021), 'Hvilke megatrender vil påvirke framtidens transportsystemer?', https://www.toi.no/forsker-til-lunsj/hvilke-megatrender-vil-pavirke-framtidens-transportsystemer-article36993-1938.html. Presented at TØI-webinar "Forsker til lunsj" on the 26th of May 2021 (Read 26.05.2021).

Langeland, O., Andersson, M. and Flotve, B. L. (2021), 'Changes and challenges in future transport - drivers and trends', https://www.toi.no/getfile.php?mmfileid=56201. TØI-report 1840/2021. (Read 28.05.2021).

Lepori, C., Banzi, M. and Konstantinopoulou, L. (2010), 'Stakeholders' needs. citylog deliverable d1.2.', https://trimis.ec.europa.eu/sites/default/files/project/documents/20130813_150852_54892_CITYLOG_D1.2_StakeholdersNeeds.pdf. (Read 08.11.2020).

London Data Commision (2020), 'Data for london - recommendations from the london data commission', https://www.londonfirst.co.uk/sites/default/files/documents/2020-09/LDCReport_.pdf. (Read 26.11.2020).

LUKS, NLF and NHO-LT (2014), 'Bransjestandard for varelevering', https://www.ohf.no/wp-content/uploads/2015/06/bvl_4b2749c268487908.pdf. By Leverandørenes Utviklings- og Kompetansesenter, Norges Lastebileier-Forbund and NHO Logistikk og Transport. (Read 17.12.2020).

Malterud, K., Siersma, V. D. and Guassora, A. D. (2016), 'Sample size in qualitative interview studies: Guided by information power'. Access acquired through NTNU Oria and SAGE Research.

MDS Transmodal (2012), 'Dg move european commission: Study on urban freight transport', https://ec.europa.eu/transport/sites/transport/files/themes/urban/studies/doc/2012-04-urban-freight-transport.pdf. (Read 08.11.2020).

Meld. St. 33 (2016 –2017) (2017), 'Nasjonal transportplan 2018–2029', https://www.regjeringen.no/contentassets/7c52fd2938ca42209e4286fe86bb28bd/no/pdfs/stm201620170033000dddpdfs.pdf. Meld. St. 33 (2016–2017) (Read 02.12.2020).

Meyer, A. and Meyer, D. (2013), 'City logistics research a transatlantic perspective - summary of the first eu-u.s. transportation research symposium', https://www.fondazioneitl.org/wp-content/uploads/City-Logistics-Research-A-Transatlantic-Perspective.pdf. May 30–31, 2013 The National Academy of Sciences Building Washington, D.C. (Read 08.11.2020).

Mjøsund, C. S., Pinchasik, D. R. and Hovi, I. B. (2020), 'Fremtidens godstransportmodeller, litteraturgjennomgang og utviklingsområder', https://www.toi.no/getfile.php?mmfileid=55033. TØI rapport 1807/2020. (Read 21.01.2021).

Moltzau, I. (2020), 'Varedistribusjon med lastesykler i byområder - modellering av rutevalg'.

Natvig, M. K., Hovi, I., Caspersen, E., Wienhofen, L. and Westerheim, H. (2016), 'Rammeverk for nye og bedre godsdata', https://sintef.brage.unit.no/sintef-xmlui/bitstream/handle/11250/2434606/SINTEF%2bA27918.pdf?sequence=2&isAllowed=y. Sintefrapport A27918/2016. (Read 12.12.2020).

Neghabadi, P. D., Samuel, K. E. and Espinouse, M. (2019), 'Systematic literature review on city logistics: overview, classification and analysis', https://doi.org/10.1080/00207543.2018.1489153. International Journal of Production Research, 57:3, 865-887. (Read 04.11.2020).

Nenseth, V. and Klimek, B. (2019), 'Mobilitetsendringer som følge av nye handelskonsepter', https://www.toi.no/getfile.php?mmfileid=52081. TØI rapport 1720/2019 (Read 10.12.2020).

Ogden, K. W. (1992), *Urban Goods Movement - A Guide to Policy and Planning*, Ashgate.

Otte, T., Gannouni, A. and Meisen, T. (2020), 'The future of urban freight transport: A data-driven consolidation approach to accompany cities on their path to zero redundancy in freight movement', https://www.researchgate.net/publication/343737707_The_future_of_urban_freight_transport_A_data-driven_consolidation_approach_to_accompany_cities_on_their_path_to_zero_redundancy_in_freight_movement. Virtual ITS European Congress, 9-10 November 2020, Paper number ITS-20357. (Read 02.02.2021).

Otte, T. and Meisen, T. (2020), 'Digitized urban freight transport: A data-driven maturity model', https://aetransport.org/past-etc-papers/conference-papers-2020?abstractId=6896&state=b. European Transport Conference 2020. (Read 28.01.2021).

Otte, T., Solvay, A. F. and Meisen, T. (2020), 'The future of urban freight transport: Shifting the cities role from observation to operative steering', https://publications.rwth-aachen.de/record/785116/files/785116.pdf. Proceedings of 8th Transport Research Arena TRA 2020, April 27-30, 2020, Helsinki, Finland. (Read 02.02.2021).

Patier, D. (2008), 'Issue 3. methodology for data collection', http://www.bestufs.net/download/Roundtables/4th_Roundtable_Rome08/Minutes_Roundtable_Rome_2008.pdf. Minutes of the BESTUFS II, WP3, 4th Roundtable, Roma (Read 10.11.2020).

Patier, D. and Routhier, J. (2008), 'Bestufs best practice in data collection, modelling approaches and application fields for urban commercial transport models. deliverable d3.2', http://www.bestufs.net/download/BESTUFS_II/key_issuesII/BESTUFS_II_results_datacollection/Del_32_data_collection.pdf. www.bestufs.net (Read 10.11.2020).

Pitera, K. (2020), *City Logistics*, NTNU. (Lecture held in the course Sustainability Issues in Transport at NTNU 10.11.2020).

Pitera, K., Pokorny, P., Kristensen, T. and Bjørgen, A. (2017), 'The complexity of planning for goods delivery in a shared urban space: a case study involving cyclists and trucks', https://sintef.brage.unit.no/sintef-xmlui/handle/11250/2588224. European Transport Research Review. 2017, 9 (46). (Read 04.03.2021).

Presttun, T. (2019), 'Næringslivets transporter i fremtidens byer', https://www.vegvesen.no/_attachment/2845187/binary/1349226?fast_title=N%C3%A6ringslivets+transporter+i+fremtidens+byer.pdf. Presented on Teknologidagene 21.09.2019 (Read 13.12.2020).

Presttun, T., Håvik, A. B., Nyland, P. G. and Nørbech, T. (2018), 'Nasjonal transportplan 2022-2033 - bylogistikk', https://www.jernbanedirektoratet.no/contentassets/b67e526f127d42fdb985ce6ea6550ea3/by/2018-12-14-ntp-bylogistikkrapport.pdf. Part of the work with the subject City areas in NTP. (Read 24.03.2021).

Rindli, J. A. (2016), 'Digitalisering i forsyningskjeden – omfatter mer enn bare teknologi', https://www.tungt-logistikk.no/article/view/732269/digitalisering_i_forsyningskjeden_omfatter_mer_enn_bare_teknologi. (Read 14.12.2020).

Routhier, J. (2008), 'Issue 4. integration: Integration of urban goods movement into the whole urban transport system', http://www.bestufs.net/download/Roundtables/4th_Roundtable_Rome08/Minutes_Roundtable_Rome_2008.pdf. Minutes of the BESTUFS II, WP3, 4th Roundtable, Roma (Read 10.11.2020).

SAGE Publications (2017), 'Data literacy: A user's guide - data defined'. Access acquired through NTNU Oria and SAGE Research.
URL: *https://methods.sagepub.com/base/download/BookChapter/data-literacy/i324.xml*

Solem, L. K. (2019), 'Norske netthandelsgiganter kaster seg på amazon-modell: Hagen og varner gjør oppkjøp innen hjemlevering', https://www.dn.no/handel/porterbuddy/canica/jernia/norske-netthandelsgiganter-kaster-seg-pa-amazon-modell-hagen-og-varner-gjor-oppkjop-innen-hjemlevering/2-1-718881. DN.no (Read 13.12.2020).

Sonntag, H. and Meimbresse, B. (2008), 'Issue 2. methodology for modelling: State of the art about urban freight modelling in europe', http://www.bestufs.net/download/Roundtables/4th_Roundtable_Rome08/Minutes_Roundtable_Rome_2008.pdf. Minutes of the BESTUFS II, WP3, 4th Roundtable, Roma (Read 10.11.2020).

Stanisław, I., Kijewska, K. and Malecki, K. (2015), 'Data flows in urban freight transport management system', https://www.researchgate.net/publication/310541318_Data_Flows_in_Urban_Freight_Transport_Management_System. International Conference on Transport Systems Telematics (Read 11.11.2020).

Stanisław, I., Malecki, K. and Korczac, J. (2013), 'Impact of telematics on efficiency of urban freight transport', https://link.springer.com/chapter/10.1007%2F978-3-642-41647-7_7. (Read 11.11.2020).

Steenberghen, T., Pourbaix, J., Moulin, J., Bamps, A. and Keijers, S. (2013), 'Study on harmonised collection of european data and statistics in the field of urban transport and mobility', https://ec.europa.eu/transport/sites/transport/files/themes/urban/studies/doc/2013-05-harmonised-collection-data-and-statistics-urban-transport.pdf. (Read 08.11.2020).

Taniguchi, E., Thompson, R. G., Yamada, T. and van Duin, R. (2001), *City Logistics. Network Modelling and Intelligent Transport Systems*, Pergamon, Oxford. (Read 08.11.2020).

Tørset, T., Kwong, C. K., Lu, C. and Aakre, A. (2020), 'Bytrans: Hvordan forklarer modellverktøyene endringer i veikapasitet i bytransport? en gjennomgang av datakilder og case brynstunnelen'. TØI rapport 1797/2020 (Read 02.12.2020).

United Nations (2019), 'World urbanization prospects: The 2018 revision (st/esa/ser.a/420).', https://population.un.org/wup/Publications/Files/WUP2018-Report.pdf. (Read 12.11.2020).

van den Bossche, M., Maes, J., Vaneslander, T., Macário, R., Reis, V. and Dablanc, L. (2017), 'Indicators and data collection methods on urban freight distribution', https://doc.anet.be/docman/docman.phtml?file=.irua.5fc710.165613.pdf. Non-binding guidance documents on urban logistics N 6/6, European Commission (Read 08.10.2020).

6 Appendix

6.1 Urban freight transport indicators

Indicators for urban freight transport based on Patier and Routhier (2008), Fossheim et al. (2010) and Halatsis et al. (2016).

		Indicator	Source
UFT/CL	Loading/unloading activities	Share of illegal on-street loading/unloading in total deliveries	Halatsis et al., (2016)
		Number of loading/unloading in each activity [Number of deliveries and pick-ups per employee per time unit]	Patier and Routhier (2008)
		Loading/unloading density in a zone [Number of deliveries and pick-ups per km²]	Patier and Routhier (2008)
		Loading/unloading intensity per activity in a zone [Number of deliveries and pick-ups]	Patier and Routhier (2008)
		Loading/unloading time in a zone, per vehicle, per activity [Number of hours of on street double parking for delivery or pick-up]	Patier and Routhier (2008)
		Distance covered for Loading/unloading in a zone, per vehicle, per activity [Number of kilometres covered for one delivery or pick-up]	Patier and Routhier (2008)
	Performance	Average journey speed during peak hours	Halatsis et al., (2016)
		Average speed per round including stops to make deliveries [km/hour]	Patier and Routhier (2008)
		Average speed per round excluding stops to make deliveries [km/hour]	Patier and Routhier (2008)
		Transport efficiency [tonnes-kilometres/vehicle-kilometres]	Fossheim et al. (2010)
		Rate of empty kilometres [\% of vehicle-kilometres]	Fossheim et al. (2010), Halatsis et al., (2016)
		Trip distribution by day and time of the day [time intervals]	Fossheim et al. (2010)
		Share of deliveries/pickups made between 07:00-10:00 hrs	Halatsis et al., (2016)
		Delays for industrial transport (næringslivets transporter)	Fossheim et al. (2010)
		Average payload per kilometre per tour, per activity, per type of vehicle [ton*km]	Patier and Routhier (2008)
		Transport content [vehicle km/tonnes]	Fossheim et al. (2010)
		Quantity of goods delivered/collected (average size of goods delivered/ collected per drop)	Halatsis et al., (2016)
	Delivery conditions	Stop times for deliveries (average dwell time) [minutes per delivery]	Fossheim et al. (2010), Patier and Routhier (2008)
	Size and extent	Freight transport performance in terms of tonnes-kilometres (transportarbeid)	Fossheim et al. (2010), int
		Freight transport performance in terms of vehicle-kilometres (trafikkarbeid).	Fossheim et al. (2010), int
		Total distance travelled on roads in urban area transporting goods by HGV, rigid lorries, and LGV	Patier and Routhier (2008)
		Number of vehicles involved in deliveries and pick ups per hour per type per size [Number of vehicle /h]	Patier and Routhier (2008)
		Average distance travelled per pick up/delivery [Km per pick up or delivery]	Patier and Routhier (2008)
		Number of deliveries/ collections [average number per establishment per week]	Halatsis et al., (2016)
		Journey length (average round trip length)	Halatsis et al., (2016)
	Vehicles	Share of trips undertaken by ennvironmental-friendly means	Halatsis et al., (2016)
		Distances covered by vehicle use	Fossheim et al. (2010)
		Distances covered by vehicle use	Fossheim et al. (2010)
		Share of delivery trips made by vehicles of less than 3.5 t gvw	Halatsis et al., (2016)
Environment	Energy use	Energy used by mode [GWh/year]	Fossheim et al. (2010)
	Emissions	Total emissions (local emissions and GHG emissions) by mode [tonnes/year or tonnes/year/capita]	Fossheim et al. (2010)
		Emissions (local and GHG) per tonnes-km and per vehicle-km [gram/km]	Fossheim et al. (2010)
		Greenhouse gas and pollution according to the zone, the vehicle, the activity, the management (g Pollutant per km; g CO2 per km; litre of fuel per km)	Patier and Routhier (2008)
	Land use	Average length of the first leg from platform to the delivery area	Patier and Routhier (2008)
		Size of land used for freight facilities [m2/capita]	Fossheim et al. (2010)

6.2 Interview guide for planners/researchers/policy makers

Intervju med planleggere/forskere/beslutningstakere

Overordnet formål med intervjuet

- *Hvordan jobber du med godstransport på bynivå gjør i dag, og på bakgrunn av hvilken informasjon/data?*
- *Hvilke analyser/evalueringer ville vært nyttige å kunne gjennomføre, for å få hvilke resultater? Hvilken informasjon/data ville være mest verdifull for disse?*

Ønsker å diskutere de fire punktene nedenfor ut fra din erfaring. Under hvert av punktene er det listet noen spørsmål som kan være et utgangspunkt for diskusjonen.

Erfaringer med å jobbe med godstransport i by

- Hvordan jobber du med godstransport i by i dag?
- Har du noen utfordringer med det? Spesifikt knyttet til tilgang på data/informasjon?

Behovet for et analyseverktøy

- Jobber du med noen problemstillinger innen godstransport på byskala som hadde vært bedre løst med analyseverktøy som du ikke har?

Ut fra behovet for et analyseverktøy, hvordan ville du beskrevet det?

- Hvilke resultater ville du hatt ut av det, hvor detaljert?
- Planleggingshorisont?
- Input? Output?
- Hvilken informasjon/data ville være viktigst for å få de ønskede resultatene?

Trender - fremtidens godstransport

- Hvilke trender tror du påvirker godstransporten i by fremover?
- Hva er drivkreftene bak denne utviklingen?
- Hvordan tror du det påvirker dine oppgaver?

6.3 Interview guide for carriers

Intervju med transportører

Hva ønsker jeg å vite:

- *Hvilken data samler dere inn og hvordan bruker dere den i dag? Hvilke data er dere villig til å dele, og under hvilke forhold?*

Innledende spørsmål

- Hva slags godstransport driver dere med?
- Har dere noen utfordringer knyttet til fremkommeligheten/tilrettelegging for transporten deres i by i dag?
- Hvordan planlegges transporten deres? Er den dynamisk?

Godstransportdata

Dagens situasjon generelt og datadeling generelt

- Hvilken godstransportdata bruker dere? Og hvordan bruker dere den/til hva?
- Ser dere verdi i å generelt dele data?
- Hvilken informasjon er dere generelt villige til å dele? For eksempel sporingsdata på kjøretøyene? Registreringsnummer?
- Hvilke forhold måtte vært til stede for å dele data på stor skala/til en felles database operert av en tredjepart? Anonymisering? Aggregering? Dugnad? Historisk data? Annet?
- Hvordan fungerer datauttrekk fra systemene deres? Generelt/knyttet til datakategoriene i det følgende.

Datakategorier presentert og datadeling spesifikt

Går gjennom listen.

- Samler dere inn denne dataen?
- For hvilket formål?
- På hvilket format?
- Med hvilken hyppighet? Hvor ofte oppdateres den.
- Er dere villige til å dele denne dataen? Hvorfor/hvorfor ikke.
- Under hvilke forhold: aggregeringsnivå etc.

Godstransportmodell i by

En fremtidig godstransportmodell på byskala

- Ser dere verdi i en felles godstransportmodell med data fra alle transportører som gir oversikt over all godstransport i byen? For eksempel for deres egen drift/egne tjenester.
- Vil dere være brukere av en slik modell?

Om fremtidens godstransport

- Hvordan tror dere godstransporten vil organiseres i fremtiden?
- Hva er drivkreftene bak denne utviklingen?

6.4 Data categories presented to carriers

Kategori		Disaggregert data	Bruk	Format
Leveransedata	1	Startsted	Transportstrømmer, generering	Postnummer? Kvartal?
	2	Leveransested	Transportstrømmer, attrahering	Postnummer? Kvartal?
	3	Planlagt leveransetidspunkt	Transportstrømmer, tidsperspektiv	Sekund? Minutt? Time? Dag?
	4	Faktisk leveransetidspunkt	Trafikkbilde	Sekund? Minutt? Time? Dag?
	5	Dimensjon	Transportmiddelbehov	Meter? Centimeter?
	6	Volum (avledet av dinemsjon)	Transportmiddelbehov, omfang	Kubikkmeter? Liter?
	7	Vekt	Transportmiddelbehov, omfang	Kg? Tonn?
	8	Sektor	Transportstrømmer, omfang	Kategorisert - renovasjon, dagligvare etc.?
	9	Lasttype	Transportstrømmer	Kategorisert - innunder sektor?
	10	Mottakertype	Attrahering, transportstrømmer	F.eks. næringslokasjon, bosettingslokasjon, ompakking?
	11	Mengde	Transportmiddelbehov, omfang	En pakke? Flere pakker?
	12	Verdi	Verdien av bedre infrastruktur	Kategorisert - lav, middels, høy?
	13	LeveranseID	Modellere hele transportkjeder	Gjennomgående for hele kjeden?
	14	Hyppighet for leveranse	Transportstrømmer, omfang	Daglig? Ukentlig? Månedlig? Dynamisk?
Kjøretøysdata	15	Transportør	Transportmiddelbehov, omfang	Kategorisert - sektor?
	16	Type	Omfang	Lastebil? Lastesykkel? Etc.
	17	Dimensjoner	Arealbruk, påvirknig på trafikken	Meter? Centimeter?
	18	Posisjon (GPS)	Transportstrømmer, trafikkbilde	Postnummer? Kvartal? Koordinat? Hvilken tidsoppløsning?
	19	Lastekapasitet	Transportmiddelbehov	Kubikkmeter? Liter?
	20	Lastfaktor	Kapasitet, effektivitet	Prosent? Hvilken tidsoppløsning? Underveis?
	21	Rute	For beslutningskriterier for rutevalg	Følger den en rute?
	22	Stoppetider	Trafikkbilde	Sekund? Minutt? Time? Dag?
	23	Destinasjon	Transportstrømmer, attrahering	Postnummer? Kvartal?
	24	Drivstoff	Eksternaliteter av godstransporten	Elektrisk? Fossilt brennstoff?
Transportnettverk	26	Hub-lokasjon	Transportstrømmer, transportmiddelbehov	Postnummer? Kvartal?
	27	Hub-kapasitet	Transportstrømmer	Kvadratmeter? Kubikkmeter?
	28	Hub-lastfaktor	Transportstrømmer, effektivitet	Prosent? Hvilken tidsoppløsning?

6.5 Invitations to planners/researchers/policy makers

Trondheim, 15. februar 2021

NTNU
Norwegian University of Science and Technology

Vil du delta i forskningsprosjektet
Innsamling av godstransportdata i by
- Undersøkelse av metode, potensial og barrierer

Dette er et spørsmål til deg om å delta i et kvalitativt intervju for min masteroppgave hvor formålet er å undersøke datagrunnlag for bylogistikk.

I dette skrivet får du informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Prosjektet er min masteroppgave ved Bygg- og miljøteknikk på NTNU, med spesialisering innen transport. Formålet med oppgaven er å undersøke om innsamling av godstransportdata fra transportører til en godstransportmodell på byskala kan bidra til mer effektiv bylogistikk, i så fall på hvilken måte, i tillegg til hvordan tilgang til dataen kan muliggjøres.

Beskrivelse av oppgaven

Bakgrunn

Prognosene peker på stor vekst i godstransporten. Trender som urbanisering, økt netthandel og hjemlevering fører til mer kamp om plassen i byene og endring i godstransporten og varestrømmene. Samtidig skal veksten i persontrafikk med bil elimineres gjennom målrettede tiltak og restriksjoner i tråd med nullvekstmålet. Godstransport vil derfor utgjøre en større andel av trafikken i by fremover, og effekten tiltakene har på godstransporten vil være større enn den er i dag. En rekke innovative løsninger kan bidra til mer effektiv bylogistikk. Uavhengig av hvilken løsning man skal implementere, er det imidlertid sentralt å gjøre det på en god måte, som innebærer evnen til å forutsi og estimere fremtidige transportvolumer og påvirkningen av tiltakene på trafikken, inkludert effekten på selve godstransporten. For å være i stand til dette, er pålitelige og høykvalitetsdata om godstransport på byskala nødvendig, for eksempel i en urban godstransportmodell. I dag mangler imidlertid offentligheten tilgang på detaljert kunnskap om godstransporten i norske byer. En av årsakene til dette, er at transportører og andre aktører i godsmarkedet er tilbakeholdne med å dele data av markedshensyn. Ny teknologi gjør at godstransportdata samles inn i økende grad, og muliggjør effektiv datadeling.

Forskningsspørsmål

Dette har gitt følgende forskningsspørsmål for masteroppgaven:

1. Hvordan kan analyser av godstransport i by bidra til mer effektiv bylogistikk? Hvilken type data trengs for analysene, og hvordan kan det samles inn?
2. Hva er barrierene for at godstransportører skal dele denne dataen, og hvordan kan disse unngås?
3. Hvilke muligheter gir nåværende datasett fra transportørene for modellering av godstransport i by? Hvilke behov kan dataen dekke? Hvilken data mangler?
4. Hvilke metoder eller verktøy er nødvendig for å håndtere dataen på en måte som oppfyller kravene til disse transportørene?

Metode

Det første spørsmålet undersøkes gjennom intervjuer med planleggere, forskere og politikere involvert i bylogistikk, **og er intervjuet du inviteres til**. Utvalget vil bli intervjuet om hvilke analyser dere gjør i dag, på bakgrunn av hvilken informasjon/data, samt hvilke muligheter/innsikt et analyseverktøy for godstransport i by kan gi, og hvilken data som ville være mest verdifull for dette. Funnene vil bli brukt til å undersøke hvilket

potensial det å samle inn utvalgte data om urban godstransport til en felles modell ville ha for planlegging for mer effektiv bylogistikk, og hvilke egenskaper en slik modell bør ha, og dekker første del av hypotesen. Intervjuene vil gi innsikt i hvilke data som er mest etterspurt, og hvilke data som kanskje ikke er nødvendige. Dette kan gi en indikasjon på hvordan man bør starte systematisk arbeid med innsamling og bruk av godstransportdata på byskala.

Prosjektet foregår fra januar til juni 2021. Opplysningene som innhentes gjennom intervjuene skal kun benyttes (bearbeidet) til denne studien, og håndteringen av opplysningene blir beskrevet i det følgende.

Hvem er ansvarlig for forskningsprosjektet?

Professor Trude Tørset ved NTNU er ansvarlig for prosjektet, som veileder. Asplan Viak er også med som bidragsyter, i form av at jeg mottar et stipend og veiledning som deltager på Asplan Viak-programmet. Dette påvirker ikke studiens resultater, da resultatene er helt uavhengige av firmaet.

Hvem skal intervjues?

Utvalget blant planleggere og forskere som kontaktes, er:

- Forskere, som jobber med bylogistikk og spesifikt godstransportstrømmer (TØI/Sintef).
- Planleggere på nasjonalt nivå (Statens vegvesen).
- Planleggere i privat sektor (i rådgivende firmaer).
- Planleggere på lokalt nivå (i kommune/fylke).

Henvendelsen sendes til ca. 10-15 aktører. Hovedsakelig kontaktes personer i Trondheim og Oslo. Utvalget baserer seg på norske aktører, og utføres således i et norsk perspektiv. Det vil imidlertid bli sett i lys av norske forhold, og på den måten diskutert hvilken overførbarhet resultatene har.

Hvorfor får akkurat du spørsmål om å delta?

Du får spørsmål om å delta på bakgrunn av din erfaring med bruk av godstransportdata og planlegging av/forskning på godstransport i by. De erfaringene du har gjennom tilgang til og bruk av godstransportdata i dag, og potensiell bruk av godstransportdata i en modell, er verdifull for studien.

Hva innebærer det for deg å delta?

Hvis du velger å delta i prosjektet, innebærer det å delta på ett hvor det avsettes to timer. Intervjuene er semi-strukturerte, og går ut fra et sett datakategorier innen godstransport og spørsmål jeg har identifisert, som du får tilsendt før intervjuet. Disse datakategoriene og spørsmålene er bare et utgangspunkt for intervjuet, og verdien i metoden og studien ligger i å høre dine tanker rundt dette.

Dersom du ønsker får du tilsendt oppgaven når den er innlevert og godkjent.

Praktisk gjennomføring av intervjuet

Intervjuene vil foregå over Teams/Zoom med tanke på covid-19. Intervjuene vil bli tatt opp. Dette er for å sikre at transkriberingen og bearbeidingen av materialet blir av så høy kvalitet som mulig, samt at ikke alt fokus under intervjuet er på å notere. Det gir meg også muligheten til å kontakte deg i ettertid dersom det er noe jeg stusser over eller ønsker utdyping på i ettertid. Du vil få tilsendt transkriberingen for å komme med eventuelle justeringer eller korrigeringer. Dersom det er absolutt ikke ønskelig med opptak, kan vi diskutere det.

I utgangspunktet er omfanget ett intervju. Jeg ønsker likevel tilbakemelding på om du kunne være interessert i et oppfølgingsintervju dersom det skulle vise seg å være relevant.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger (ditt navn og eventuelle intervjuopptak) vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan jeg bruker og oppbevarer dine opplysninger

Jeg vil bare bruke opplysningene om deg til formålene jeg har beskrevet i dette informasjonsskrivet. Jeg behandler opplysningene konfidensielt og i samsvar med personvernregelverket. Det er bare jeg som har tilgang til dataen. Dersom det blir aktuelt, vil veileder Trude Tørset involveres i databehandlingen, og få tilgang til transkribert materiale, dersom jeg trenger hjelp til tolking. Navnet og kontaktopplysningene dine vil ikke lagres sammen med dataen samlet inn under intervjuene. Hver deltager får et nummer, som lagres sammen med navn og kontaktopplysning i et separat dokument. I bearbeidingen av dataen vil kun nummeret benyttes.

Ingen sitater eller informasjon som kan knyttes direkte til deg vil inkluderes i publikasjonen. Informasjonen fra intervjuene vil ses i sammenheng, og bare bearbeidet informasjon brukes. Dersom jeg ønsker å bruke et utsagn og din rolle, vil jeg ta kontakt og spørre om du godtar at det brukes, og om du i så fall er enig i hvordan jeg har forstått og bruker utsagnet.

I publikasjonen vil kun navn på deltagerne presenteres dersom alle godtar det. Hvis du ikke ønsker navnet ditt i oppgaven, vil kun rolle presenteres. Navnet presenteres eventuelt for at andre som jobber med samme problemstilling kan ta kontakt med dere.

Hva skjer med opplysningene dine når jeg avslutter forskningsprosjektet?

Opptakene av intervjuene slettes når de er ferdig transkribert. Dette gjøres løpende. Den transkriberte informasjonen slettes når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er i midten av juni 2021. Det bearbeidede datamaterialet inngår i prosjektoppgaven, og inneholder ikke identifiserbar informasjon på individnivå.

Dine rettigheter

Du kan ikke identifiseres i datamaterialet som presenteres offentlig.
Siden du kan identifiseres på (eventuelle) videoopptak, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Det vil si at du på etterspørsel kan få tilsendt opptaket og komme med innsigelser dersom du føler noe ble sagt eller tolket feil.

Hva gir meg rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NTNU har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan du få mer informasjon om arbeidet?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- *Johanne Lægran, johanlae@stud.ntnu.no, 45898220*
- *Trude Tørset, trude.torset@ntnu.no, 97038649*

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Johanne Lægran (sign.)
(Forsker/student)

Trude Tørset (sign.)
(Veileder)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Identification of potential, barriers and a method for obtaining urban freight transport data*, og har fått anledning til å stille spørsmål. Jeg samtykker til (sett kryss i boksene som passer):

- ☐ å delta i ett intervju, med opptak
- ☐ å delta i ett intervju, uten opptak
- ☐ å eventuelt delta i oppfølgingsintervju(er) med samme forbehold
- ☐ at navnet mitt presenteres i studien
- ☐ ønsker ikke at navnet mitt presenteres i studien

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet.

(Signert av prosjektdeltaker, dato)

6.6 Invitations to carriers

Trondheim, 15. februar 2021

NTNU
Norwegian University of Science and Technology

Vil du delta i forskningsprosjektet
Innsamling av godstransportdata i by
- Undersøkelse av metode, potensial og barrierer

Dette er et spørsmål til deg om å delta i et kvalitativt intervju for min masteroppgave hvor formålet er å undersøke datagrunnlag for bylogistikk.

I dette skrivet får du informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Prosjektet er min masteroppgave ved Bygg- og miljøteknikk på NTNU, med spesialisering innen transport. Formålet med oppgaven er å undersøke om innsamling av godstransportdata fra transportører til en godstransportmodell på byskala kan bidra til mer effektiv bylogistikk, i så fall på hvilken måte, i tillegg til hvordan tilgang til dataen kan muliggjøres.

Beskrivelse av oppgaven

Bakgrunn

Prognosene peker på stor vekst i godstransporten. Trender som urbanisering, økt netthandel og hjemlevering fører til mer kamp om plassen i byene og endring i godstransporten og varestrømmene. Samtidig skal veksten i persontrafikk med bil elimineres gjennom målrettede tiltak og restriksjoner i tråd med nullvekstmålet. Godstransport vil derfor utgjøre en større andel av trafikken i by fremover, og effekten tiltakene har på godstransporten vil være større enn den er i dag. En rekke innovative løsninger kan bidra til mer effektiv bylogistikk. Uavhengig av hvilken løsning man skal implementere, er det imidlertid sentralt å gjøre det på en god måte, som innebærer evnen til å forutsi og estimere fremtidige transportvolumer og påvirkningen av tiltakene på trafikken, inkludert effekten på selve godstransporten. For å være i stand til dette, er pålitelige og høykvalitetsdata om godstransport på byskala nødvendig, for eksempel i en urban godstransportmodell. I dag mangler imidlertid offentligheten tilgang på detaljert kunnskap om godstransporten i norske byer. En av årsakene til dette, er at transportører og andre aktører i godsmarkedet er tilbakeholdne med å dele data av markedshensyn. Ny teknologi gjør at godstransportdata samles inn i økende grad, og muliggjør effektiv datadeling.

Forskningsspørsmål

Dette har gitt følgende forskningsspørsmål for masteroppgaven:

1. Hvordan kan analyser av godstransport i by bidra til mer effektiv bylogistikk? Hvilken type data trengs for analysene, og hvordan kan det samles inn?
2. Hva er barrierene for at godstransportører skal dele denne dataen, og hvordan kan disse unngås?
3. Hvilke muligheter gir nåværende datasett fra transportørene for modellering av godstransport i by? Hvilke behov kan dataen dekke? Hvilken data mangler?
4. Hvilke metoder eller verktøy er nødvendig for å håndtere dataen på en måte som oppfyller kravene til disse transportørene?

Metode

Det andre spørsmålet vil bli undersøkt gjennom intervjuer med transportører innen ulike sektorer i godstransporten, og er intervjuet du inviteres til. Utvalget vil bli intervjuet om villigheten til å dele data, inkludert hvilke data de er villige til å dele, og under hvilke forhold. Dette vil bidra til å identifisere strategier for å få tak i verdifulle data uten å gå på akkord med deres interesser, og sammen med spørsmål tre og fire dekker det den andre del av hypotesen.

Det tredje og fjerde spørsmålet vil bli undersøkt gjennom analyse av eksempler på datasett fra de godstransportører, og det er til denne analysen vi etterspør datasett fra dere. Funnene vil bli brukt til å identifisere potensielle metoder for å hente ut data fra datasettene til en modell. Dette inkluderer tilnærminger som anonymisering eller aggregering av data.
Prosjektet foregår fra januar til juni 2021. Opplysningene som innhentes gjennom intervjuene skal kun benyttes (bearbeidet) til denne studien, og håndteringen av opplysningene blir beskrevet i det følgende.

Hvem er ansvarlig for forskningsprosjektet?

Professor Trude Tørset ved NTNU er ansvarlig for prosjektet, som veileder. Asplan Viak er også med som bidragsyter, i form av at jeg mottar et stipend og veiledning som deltager på Asplan Viak-programmet. Dette påvirker ikke studiens resultater, da resultatene er helt uavhengige av firmaet.

Hvem skal intervjues?

Utvalget som kontaktes er firmaer som transportører varer og gods i byene i Norge. Utvalget skal dekke flere sektorer innen varetransport, og på denne måten undersøke ulike perspektiver. Dette gjelder innen byggebransjen, detaljhandel og pakkelevering.

Hovedsakelig kontaktes personer i Trondheim og Oslo Utvalget baserer seg på norske aktører, og utføres således i et norsk perspektiv. Det vil imidlertid bli sett i lys av norske forhold, og på den måten diskutert hvilken overførbarhet resultatene har.

Hvorfor får akkurat du spørsmål om å delta?

Du får spørsmål om å delta på bakgrunn av din rolle som direkte involvert i godstransport i by, med tilgang på godstransportdata. De erfaringene du har gjennom tilgang til og eierskap av godsdata i dag, i tillegg til praktisk erfaring med bylogistikk, og potensiell deling av godsdata til en modell, er verdifull for studien.

Hva innebærer det for deg å delta?

Hvis du velger å delta i prosjektet, innebærer det å delta på ett intervju med to timer avsatt. Intervjuene er semi-strukturerte, og går ut fra et sett datakategorier innen godstransporten og spørsmål jeg har identifisert, som du får tilsendt før intervjuet. Dette er bare et utgangspunkt for intervjuet, og verdien i metoden ligger i å høre dine tanker rundt dette.

Dersom du ønsker får du tilsendt oppgaven når den er innlevert og godkjent.

Praktisk gjennomføring av intervjuet

Intervjuene vil foregå over Teams/Zoom med tanke på covid-19. Intervjuene vil bli tatt opp. Dette er for å sikre at transkriberingen og bearbeidingen av materialet blir av så høy kvalitet som mulig, samt at ikke alt fokus under intervjuet er på å notere. Det gir meg også muligheten til å kontakte deg i ettertid dersom det er noe jeg stusser over eller ønsker utdyping på i ettertid. Du vil få tilsendt transkriberingen for å komme med eventuelle justeringer eller korrigeringer. Dersom det er absolutt ikke ønskelig med noe opptak, kan vi diskutere det.

I utgangspunktet er omfanget ett intervju. Jeg ønsker likevel tilbakemelding på om du kunne være interessert i et oppfølgingsintervju dersom det skulle vise seg å være relevant.

Det er frivillig å delta

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger (ditt navn og eventuelle intervjuopptak) vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan jeg bruker og oppbevarer dine opplysninger

Jeg vil bare bruke opplysningene om deg til formålene jeg har fortalt om i dette informasjonsskrivet. Jeg behandler opplysningene konfidensielt og i samsvar med personvernregelverket. Det er bare jeg som har tilgang

til dataen. Dersom det blir aktuelt, vil veileder Trude Tørset involveres i databehandlingen, og få tilgang til transkribert materiale, dersom jeg trenger hjelp til tolking. Navnet og kontaktopplysningene dine vil ikke lagres sammen med dataen samlet inn under intervjuene. Hver deltager får et nummer, som lagres sammen med navn og kontaktopplysning i et separat dokument. I bearbeidingen av dataen vil kun nummeret benyttes.

Ingen sitater eller informasjon som kan knyttes direkte til deg vil inkluderes i publikasjonen. Informasjonen fra intervjuene vil ses i sammenheng, og bare bearbeidet informasjon brukes. Dersom jeg ønsker å bruke et utsagn og din rolle, vil jeg ta kontakt og spørre om du godtar at det brukes, og om du i så fall er enig i hvordan jeg har forstått og bruker utsagnet.

I publikasjonen vil kun navn på firmaet og kontaktperson presenteres dersom alle godtar det. Hvis du ikke ønsker firmaet ditt eller kontaktperson nevnt i oppgaven, vil kun sektor presenteres. Firmanavnet og/eller kontaktperson presenteres eventuelt for at andre som jobber med samme problemstilling kan ta kontakt med dere.

Hva skjer med opplysningene dine når jeg avslutter forskningsprosjektet?

Opptakene av intervjuene slettes når de er ferdig transkribert. Dette gjøres løpende. Den transkriberte informasjonen slettes når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er i midten av juni 2021. Det bearbeidede datamaterialet inngår i prosjektoppgaven, og inneholder ikke identifiserbar informasjon på individnivå.

Dine rettigheter

Du kan ikke identifiseres i datamaterialet som presenteres offentlig.
Siden du kan identifiseres på (eventuelle) videoopptak, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Det vil si at du på etterspørsel kan få tilsendt opptaket og komme med innsigelser dersom du føler noe ble sagt eller tolket feil.

Hva gir meg rett til å behandle personopplysninger om deg?

Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra NTNU har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan du få mer informasjon om arbeidet?

Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- *Johanne Lægran, johanlae@stud.ntnu.no, 45898220*
- *Trude Tørset, trude.torset@ntnu.no, 97038649*

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen

Johanne Lægran (sign.)
(Forsker/student)

Trude Tørset (sign.)
(Veileder)

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet *Identification of potential, barriers and a method for obtaining urban freight transport data*, og har fått anledning til å stille spørsmål. Jeg samtykker til (sett kryss i boksene som passer):

- ☐ å delta i ett intervju, med opptak
- ☐ å delta i ett intervju, uten opptak
- ☐ å eventuelt delta i oppfølgingsintervju(er) med samme forbehold
- ☐ at firmanavnet presenteres i studien
- ☐ ønsker ikke at firmanavnet presenteres i studien
- ☐ at mitt navn presenteres i studien
- ☐ ønsker ikke at navnet mitt presenteres i studien

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet.

(Signert av prosjektdeltaker, dato)

6.7 Abbreviations used in the results

Abbreviations/denotations used in the results:

- UFT = Urban freight transport
- Pm = Policy maker
- P-Pr = Private planner
- P-Pu = Public planner
- R = Researcher
- NGM = Den nasjonale godstransportmodellen
- 3PL = Third-party logistics company.
- HV = Heavy vehicle
- RTM = Regional transportmodell
- HSE = Health and safety at work
- G = Grocery carrier
- L = Logistics carrier
- C = Construction carrier

6.8 Result tables from interviews with the planners/researchers/policy makers

Challenges related to data:

	Challenge	Consequence	Mentioned by
Data collection	Disagreement around method, numbers and statictics due to lack of data	No common factual basis for policy making, leading to political disagreement regarding transport issues	Pm
	Data being hidden by the public authoroties because "it is competition sensitive", especially rail related statistics	Difficult to do analyses	P-Pr
	Acuiring data from the carriers	More case oriented projects, where it is easier to get data	P-Pr
	Lack of budget to collect data		P-Pr
	Different formats/definitions on the data (counts being based on length, SSB using 3.5 tonnes nyttelast, SVV 3.5 tonnes total weight)	Difficult to match different data basises (datagrunnlag)	P-Pu
	Time consuming survey data collection		P-Pu
	Having data collected one or very few times	Can not compare data over time, thus not know the development	P-Pu
Data characteristics	Data in NGM being outdated locally in 2-3 years (generally within UFT - lots of changes happening, expires faster than personal traffic data)		P-Pr, P-Pu
	Difficult to get data on higher spatial resolution than there is in NGM today		P-Pr
	Easier to have good data on commodity flows between municipalities/places than internally in a city		P-Pr
	Due to lack of data one has to use assumptions for the specific area being investigated	Might be very different for different measures	P-Pr
		Difficult to prioritize funding	P-Pr
	Lack of available relevant data/information and small samples for surveys in smaller cities	Uncertain data basis	P-Pr
	There is probably available data, but it is not connected (satt sammen) due to lack of knowledge on how the planners want to have info		R
	Lack of data for doing evaluations	Difficult to learn from previous mistakes	R

Challenges with obtaining data from carriers:

Challenge	Possible solution	Mentioned by
Numerous commodity flows in a city, would be many to contact to ask for data	Get data from the largest distributors in cities, such as Postnord, Bring osv	P-Pr
Different transport chains are difficult to incorporate together - some uses 3PL, others not.		P-Pr
Competition	Collecting data with common standards from public user pesrpective, nothing affecting the market, no distortiion of the competition (konkurransevridning)	R
Willingness to share data	Have to know what data is wanted and convincing the carriers that will be used for better city logistics, and not in a competitive situation	R
The legal aspect of data sharing		P-Pu

Challenges related to current analysis tools:

Challenge	Consequence		Mentioned by
The zones in NGM are too large for working secure in cities	The distribution on road links is not exact/precise		P-Pr, P-Pu
Lack of integration between the freight model and personal transport models for socio-economic analyses	Important for whether projects are realized or not based on socio-economic analyses, as the value of saved time is larger for freight than personal traffic	Wrong prioritzation of projects, might report relatively too low benefit in the urban projects with larger capacity problems compared to more rural projects with less capacity problems	P-Pr, P-Pu
NGM do not handle capacity problems	Do not capture the potential benefits of reducind wueue with measures		P-Pr
No variation over the day			P-Pr
Lack of possibility to simulate expected effects of measures	Could have implemented measures differently. Have to test in real life - expensive and less efficient. Difficult to know the impact		R, P-Pu

Approaches being used because of lack of data and analysis tools:

Approach being used	Mentioned by
Use involvement and dialouge to get a common factual basis to give to the policitians, in order to agree on what the politics are based upon	Pm
Static share of HVs often in socio-economic analyses	P-Pr
Have to mention the potential benefits fro freight without quantifying it, or quantify it with a lot of uncertainty and difficulty	P-Pr
Qualitative approach, involve carriers to dialouge	R, P-Pr

Specific data gaps:

Data gap	Consequence	Mentioned by
Do not know when the freight is transported, related to delay and rush		P-Pr
Difficult to verify estimations of freight from volumes onto vehicles		P-Pu
Large lack of data (knowledge) on transport with vans	Do not have data on a large share of the traffic, lots of vans in urban distribution. Related to the traffic counts - counting on length, and vans being shorter than 5,6m	P-Pu
Lack of data (knowledge) on distribution routes	Have sufficient info on direct transport, but not on routes. Do not know where they have been or number of stops	P-Pu
Lack of data (knowledge) on stops - the quantity and time use	Do not capture e.g. the effect of making the "50 last feet" (from car to recipient) more efficient	P-Pu
Lack of knowledge (data) on the vehicle fleet (kjøretøysparken) driving in the cities - quantity, type, size		P-Pu
Lack of knowledge on the actors serving the distribution in cities, which also varies over time (e.g. construction sector)	Do not know who to ask for data, and it's representativeness	P-Pu
Delivery conditions (leverinsbetingelser) for the transport	Do not know how demands will affect the actors - i.e. not how to set demands. Difficult to aquire - confidentiality	P-Pu
Lack of knowledge/data on the recipient of freight	Can know the freight type, but a lot of freight types is used by different recipient types	P-Pu
Expected traffic generation/production from different areas/functions		P-Pr
The freight quantity (volume) into different areas, and the total volume in a city		P-Pr

Need for analysis tools:

	Want to have	Mentioned by
New knowledge	Better exploitation of existing capacity in the urban freight vehicles	P-Pu
	Reduce freight transport need and traffic to avoid freight transport using released capacity from the zero-growth goal	P-Pu
Related to having knowledge based on numbers	Agreement on the factual basis for policies	Pm
	Say something about the current situation	P-Pu, P-Pr
	Control and further estimation of NGM and RTM	P-Pu
	Control of actual volume of freight transport in order to do socio-economic analyses, to quanitify the benefits for freight transport	P-pr
	Better prognosis of the transport on the road network to use in cost-benefit analyses	P-Pu
Related to the effect of measures	See the effect of measures	P-Pu, P-Pr
	Evaluating measure to scale up or not implement	Pm
	To comunicate the benefit or evaluation criterias to make ideas interesting for private actors	P-Pu

Data needs for an analysis tool:

	Data	To	Comment	Mentioned by
For deliveries	Volumes delivered	Generate commodity flow analyses	Not necessarily address, but suited to relate commodity flows to	P-Pr
	Quantities - how many packages, how many units			P-Pr, R
	From who - a city terminal or distribution from post i butikk/post offices, ot company flows from company to company			P-Pr, R, P-Pu
	To who (recipient) - different offices/buildings, cafes, indistry etc.			P-Pr, P-Pu
	Time stamps	Evaluate delay and effect of capacity problems/rush, see when the demand is highest. Also to weigh the benfit after time of day		P-Pr
	Number of vehicles			R
	Distribution pattern			R, P-Pu
	Dependency between larger 3PL and small acttors			R
	Number of stops			P-Pu
	Time use for stops			P-Pu
On the vehicle fleet	Type			P-Pu
	Size			P-Pu
	Number			P-Pu

Characteristcs of an analysis tool:

Aspect	Problem today	Possible solution	Difficulty	Impact	Mentioned by
Spatial resolution	Too large zones	Smaller zones	Difficult to obtain detailed enough data	Integration with RTM, so they can be integrated	P-Pr
			The tool will become heavy		P-Pr
Temporal	Too large	Simulate the traffic for			P-Pr
Vehicle fleet	Not detailed enough for urban areas, new solutions not included, smaller units not included	Need to differentiate more. Model costs and characteristics of transport modes. Differentiate environmentally friendlyness.		On the emission	P-Pr
Capturing the heterogenity of UFT	Do not capture he heterogenity of UFT	Include more sectors. E.g. define renovation as a type of freight	Need high resolution of pick up/delivery points		P-Pr
		Include Interaction between personal and freight traffic		Be able to model possible future innovations/solutions. Exploit free capacity	P-Pr
Capture multimodality of UFT		Include the walking time from parking to the destination, which affects the stop times	Happens on a small scale.	Be able to model possible future innovations/solutions.	P-Pr
Capacity	Do not capture capacity problems			Capture the benefit of removing queue	P-Pr
Interaction with other tools		By having the same resolution		Use the results from this tool in others and opposite (related to the holisticity, transport chains)	P-Pr

Measures to analyse:

Measure	To	Mentioned by
Toll ring - change in location and fee	Improve the situation for freight deliveries	P-Pr
Rerouting of personal traffic		P-Pr
Night time deliveries		P-Pu
Consolidation terminals		P-Pu
City terminals		P-Pu
Development of different areas		P-Pr

Desired results from an analysis tool:

Result	Why	Mentioned by
Number of trips to and from an area	To make the urban freight magnitude more tangible for decision makers and predict future volumes	P-Pr
External costs from emissions	Increasing attention on climate reporting among	P-Pr
Change in CO2 in different years		P-Pr
Freight transport performance in terms of tonnes-kilometres (transportarbeid)	To follow up the development of organization of transport and expect future organization	P-Pu
	Calculate traffic benefit/transport benefit of measures	P-Pr
	Accident cost	P-Pr
Freight transport performance in terms of vehicle-kilometres (trafikkarbeid)	To follow up the development of organization of transport and expext future organization	P-Pu
The relationship between these two, and development of it	To follow up the development of organization of transport and expext future organization	P-Pu
Change in travel time, including time parked and in loading/unloading zones	Calculate traffic benefit/transport benefit of measures –> prioritize projects	P-Pr
Share of emission free vehicles (Transport mode share)	Calculate petrol tax and taxes to the government, as well as related to emissions	P-Pr
The effect on the different vehicle types	Analyze how measures affect the distribution of the commodity flows	P-Pr
Volume per sending	Affects operator cost and organization of the transport	P-Pr

Trends affecting the future organization of urban freight transport:

Trend	Consequence	Modellmessig	Mentioned by
Innovation, large changes		Data expires fast	P-Pu, P-Pr
Less space in the cities - less area for loading/unloading			Pm
Solutions that combines the businesses and the transport business (nøringslivet og transportnæringen)			Pm
More energy -and climate efficient transport	Affect the air quality, but not necessarily the road capacity	Adjusting the cost model for analytical tools	P-Pr
Smaller and emission free vehicles			P-Pu, P-pr
Pick up points	Replace some home deliveries	Input the locations and volumes to them	P-Pr

6.9 Result tables from interviews with the carriers

Challenges:

Challenges	Sub-challenge	Traffic implications	Other implications	Mentioned by
Traffic regulations as one-way roads, access denied etc.,		Leading to ineffective routes between stops.		G, L
Insufficient loading zones - too few an too smal.		Driving extra rounds hoping the loading zone is free the next time. Creates queue. More HVs in the city.		G, L
Time windows for delivery		In-efficient logistics/routes - need extra vehicles, more vehicels in the network, more km driven, lack of flexibility to exploit the cars well	Extra fuel use and time use for the drivers	G, L
Narrow streets and alleys		Backing up	Safety	L, C
Freight deliveries on the street		Conflicts with other road users,	Safety	G, L
In-adequate varemottak		Delivery takes long time	Affects the RSE for the drivers	G
Strategic demands about car-free city centres				L
Demands about environmentally friendly vehicles only	Lack of willingness to pay for it			L
	Smaller vehicles specifically - volume demandsing material for temperature handling	More trips		G
A third-part owing the road network and large parts of the delivery conditions			Time consuming and challenging to facilitate good deliveries. Affects the RSE for the drivers	G

Conditions for sharing data:

Condition to share data	Mentioned by
What is easy to access, to extract from the systems	G, L
The goal of the data collection have to be better city logistics	L
Need to have defined what the data will be used to - a plan and purpose for the data, clear framework and boundaries for the use.	L
Must benefit the carriers, in terms of better planning/facilitating etc.	L
Data security. Complying with the deal about the data (not shared further,	L
Anonymization	G, L
Aggregated level	G, L
"All" carriers contributing	L

Value in an urban freight transport model for the carriers:

How the model woule be used	In order to	Value for the transporters	Mentioned by
See trends for when the demand is high, when loading areas are full, in terms of staticstics on adresses or areas. Loading zones/construction sites	Plan tactical based on that	Give info enabling better planning of their own transport –> more efficient	G, C
	Change the time window to the customer to remove deliveries in the most hectical period	More efficient distribution, less traffic	G, C
	Juggle the route/order.		G, C
	Spread deliveries throughout the day		G
See what volumes the others are transporting through the city	Align (samkjøre)	More efficient distribution, less traffic	G, C
		Urban freight transport is in	G
		Enables interaction(samhandling) between public authorities	L
		Better city logistics and urban planning that takes into account (ivaretar) the efficiency and RSE for the	G, L

Trends affecting the future organization of urban freight transport:

Trend	Sub-trend	Comment	Mentioned by
The customers want smaller time windows or to a a larger degree time windows		The deals of many of the larger customers/chains are negotiated centrally	G
More customers want time windows		Predictability being increasingly important	L
Smaller vehicle units in the city centre		Challenging with temperature regulations	G
		Only relevant for customers where one transporter delivers smaller deliveries, not full loads	G
Deliveries at evengings or nights to unattended reception points (varemottak)		For larger customers	G
Common reception points		For larger customers like shopping centres, combined with unattended deliveries	G
More regulations	Demands about car-free zones		G, L
	Demands about environmentally friendly vehicles	Fossil-free. From the authoroties and the companies themselves	G, L
	Demands about using common hubs for clustering (samlasting)	Needs high degree of collaboration, and thoughts about marketing	L
		Could be more relevant for smaller actors	L
	Demands that only few last-mile distributers can distribute	Can happen by the demands on vehicles	L
	More regulations on what times deliveries are allowed		G
More e-commerce	More home deliveries	Often on evenings	L
	More pick-up points		L

More transporters specializing in last-mile delivery		Using technology to be efficient, increases the need for common hubs	L
Price differentiation between rural and urban areas		To compete with the specialised transporters in urban areas	L
Customers increasingly wanting to send from home			L
Much of the trade and activities that took place in the city center in the past have been moved to the suburbs, where it is more convenient for cars.			L
Larger degree of autonomy			G
The large actors having to lead the development, together with customters and authoroties			G

Drivers behind the trends:

Drivers	**Mentioned by**
Sustainability	G, L, C
The customer want to everything from their couch	L
Minimizing costs	C

6.10 Content in the obtained delivery data sets

The table shows the content for the different aspects in the data sets. The information and format is noted.
The IDs have individual formats.

Sector	Carrier	Time of delivery						Stop times	Weight	Volume	Quantities	Delivery address	Delivery postal code	Delay				Delay at stop (not in traffic)		Vehicle size	Routes	Commodity flow	Sender postal code	Sending number
G	1	Delivered from date and time DD.MM.YYYY hh:mm:ss	Date and time delivered to DD.MM.YYYY hh:mm:ss					Actual delivery time min		Volume per delivery L/m^3		Delivery address Standardised, Xxx	Postal code NNNN	Delivery in time window 0/1	Delivery < 30 min before time window 0/1	Delivery after time window 0/1	Delivery before time window 0/1	Planned delivery time min	Acual delivery time min	Car size Pallets	Route ID	Shift ID		
	2	Weekday delivered 1-7	Time of delivery hh:mm:ss							Volume per delivery m^3										Car type Semi/singel	Route plan			
L	3	Date delivered DD.MM.YYYY	Delivered time hh:mm						Freight calc. weight kg		Kolli quantity #	Delivery address Not standardised	Postal code NNNN									Delivered transport number		ID
	4	Date delivered DD.MM.YYYY	Day Tuesday etc.	Week WW	Month September etc.	Time delivered hh:mm:ss	Time YY:hh:mm:ss		Weight g	Volume per delivery cm^3		Leveringsadresse Not standardised	Postal code NNNN									PDA delivered XXNNNNN	Postal code NNNN	
	5	Date and time delivered YYYY-MM-DD hh:mm							Freight calc. weight kg	Weight kg	Volume per delivery L/m^3	Kolli quantity #		Postal code NNNN									Postal code NNNN	ID
C	6	Date and time delivered DD.MM.YYYY hh:mm							Freight calc. Weight kg	Brutto weight kg	Volume per delivery m^3	Kolli quantity #	Mot. adr. Not standardised	Postal code NO-NNNN Place							Route ID	Driver order ID Delivery order	Postal code NO-NNNN Place	

Johanne Lægran

Urban freight transport data - Identification of potential and implications of collection and analysis of carrier data

NTNU
Norwegian University of
Science and Technology