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A Multi-Stakeholder Perspective on Barriers to a Fossil-Free Urban Freight System

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Abstract: The purpose of this study is to provide a system perspective on the barriers to the development of a fossil-free and thus more sustainable urban freight system and to provide insights regarding these barriers and how they impede progress. The system perspective complements earlier research, where barriers were identified in delimited parts of freight systems. Here, the urban freight system in a Swedish city is explored using an inductive and qualitative approach, according to which barriers are both detailed and categorized. This study is based on empirical data concerning the perceptions of multiple stakeholders in one system. The interrelationships between barrier categories and changes to the urban freight system are explored through management theory. This study provides a unique overview of the barriers to development in one system and insights concerning these barriers and how they impede development of the system. Ten categories of barriers are identified: technology, infrastructure, economy, knowledge, policy, goals, organization, cooperation, politics, and societal factors. The categories can be divided into four different types, which are related to each other and to the overall system in various ways, based on how they impede the development toward sustainability. Future research could advance this theoretical knowledge by continuing to study urban freight system development processes and by adding insights from other contexts, stakeholders, and theoretical areas.

Keywords: urban freight; urban logistics; urban freight system; city logistics; system perspective; barriers to change; barriers to sustainable development; barriers to fossil-free; taxonomy of barriers

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1. Introduction

Freight transport in urban areas simultaneously makes both essential contributions to and erodes the quality of life of citizens. It provides necessary supplies to both citizens and businesses and thereby supports the wealth of cities, while at the same time it causes various side effects, such as emissions, noise, congestion, and accidents, which lower the quality of life of inhabitants. Increased societal demands regarding the curbing of global warming and improving the quality of life of inhabitants in urban areas will force the urban freight transport sector to reduce the negative consequences of its activities—activities which are forecast to see a strong growth in demand over the coming decades due to continued digitalization and urbanization [1,2]. The necessity of meeting both increased capacity demands and the requirement to reduce the negative consequences of urban freight urges development toward a more efficient use of resources as well as transformation to fossil-free practices [3–5]. This transformation is one part of the development toward environmentally sustainable urban freight systems.

The necessary development toward environmentally sustainable urban freight systems [6] is, however, hindered by different types of barriers. Such barriers have been studied from a variety of different theoretical perspectives. Two literature reviews have examined barriers at the overall transport-system level. The first of these reviews identified the barriers to making freight transport generally more environmentally sustainable, including logistical, organizational, and technical barriers, as well as external prerequisites (e.g., contradictory laws and regulations) impeding change [7]. The second literature review, focusing on freight transport from a supply-chain management perspective, found cost concerns, a lack of legitimacy and commitment, policy limitations, and industry context to be influential barriers [8]. A number of narrower studies have addressed barriers to specific solutions within urban freight systems, which could have a positive impact from a sustainability perspective. For example, a study on freight partnerships identified barriers related to the ability to organize stakeholders for cooperation [9]. A study on urban consolidation center initiatives identified financial-, practical-, social-, cultural-, and goods-specific barriers [10]. Other studies have identified barriers to adopting smart lockers [11], vendor-managed inventories [12], bike sharing [13], crowd shipping [14–16], bicycle logistics [17–19], and electric and autonomous vehicles [20–22].

The two overarching reviews, which partly cover the urban freight system and the specific sustainability-related solutions within the urban freight system, together highlight the multitude of barriers to making urban freight systems sustainable. Many different, sometimes interrelated barriers that are linked to a variety of stakeholders must be overcome in order to achieve environmentally sustainable urban freight systems. This paper aims to bring some clarity to this complex reality by studying the barriers in one urban freight system and focusing on the aspect of environmental sustainability that concerns the transformation to fossil-free energy. This approach creates a holistic view of the currently quite fragmented picture of barriers in urban freight systems.

In addition to the unique urban freight system perspective, this study also aims to report empirical data, which have been called for in previous research. Scholars have argued that empirical studies exploring the multiple dimensions of urban freight systems from stakeholders' perspectives could complement earlier research [22,23] and thus provide useful insights to support the development toward local environmental goals. Applying holistic perspectives to urban freight systems can offer insights into how factors affect both one another and the system itself [24]—insights that are crucial to enabling the purposive development of urban freight systems and which can contribute to the advancement of theoretical knowledge about urban freight systems.

Hence, the purpose of this study is to offer a holistic perspective on the barriers to a fossil-free urban freight system based on empirical data concerning stakeholder perceptions within one system. A further purpose is to contribute to the understanding of these barriers, their interconnections, and how they affect the development of urban freight systems. The study was guided by the following research questions:

- Which barriers, from a multi-actor perspective, impede the development toward a fossil-free urban freight system?
- How are these barriers related to each other and to the development of the urban freight system as a whole?

In this study, the urban freight system in one of the ten biggest cities in Sweden (<200,000 inhabitants) is empirically explored through an inductive approach involving several stakeholders of different types that are active in the same system. This approach illuminates the multifaceted complexity of barriers and their relationships within an existing system. The city's extensive logistic connections and its high environmental ambitions make it interesting to study. The size of the city makes it possible to obtain an overview of its urban freight system, but this system is still large enough to offer complexity on the route to environmental sustainability.

The article applies the shorthand term "fossil-free", which is used to describe an urban freight system powered by non-fossil energy rather than a freight system that is fully disconnected from fossil components in all its dimensions (such as materials, etc.).

The rest of the paper is organized as follows: first, the status of research is described in the Theoretical Background section. This is followed by the Materials and Methods section and then the Results section. The results are interpreted in the Discussion section, and the paper is finalized in the Conclusions section.

2. Theoretical Background

The urban freight system involves many stakeholders with their own agendas [25,26]. Combining the agendas is often difficult, since the stakeholders have potentially conflicting interests [27,28]. The multitude of interests and the difficulty of fulfilling them all at the same time creates a complex situation for stakeholders in the system, with interrelated barriers which hold back a more environmentally sustainable development of urban freight systems. This combination of barriers, which might be individually manageable, often prevents the implementation of CO_2-reducing actions in companies [7]. The research on barriers and stakeholders in urban freight systems is further reviewed in the subsections below.

2.1. Actors and Stakeholders in the Urban Freight System

The stakeholders in the urban freight system can be categorized in different ways and scholars have proposed slight variations. All those who have an interest in the urban freight system can be characterized as stakeholders [29]. Those stakeholders who have a direct impact on the urban freight system are also actors in the system. The actors in urban freight systems can be categorized as shippers, customers, freight transport operators, and authorities [29]. Examples of stakeholders who are not actors, according to this definition, are NGOs, property owners, and residents [30]. Cities and municipalities assume a variety of different roles [28]. Different groups of actors and stakeholders have different agendas [28]. While companies strive to maximize profitability and customer satisfaction, authorities attempt to balance economic development with environmental goals to maximize the attractiveness of an area.

The public can use both different roles and tools to stimulate and guide the development of freight systems. Cities can use combinations of policies to guide the development of freight activities in urban areas [9,18,28]. One useful tool is the introduction of low-emission zones [31]. Another possibility for a city is to use its role as a business partner to stimulate development [32]. For the long-term survival of measures and solutions, different stakeholders' goals need to be considered [26] and a sufficient level of cooperation between relevant stakeholders must be achieved [33]. However, other aspects can also affect actors' and stakeholders' motivations and the possibilities of their contributing to change and development. Some of these aspects are discussed in the next subsection.

2.2. Barriers to a Sustainable Urban Freight System

A thorough understanding of the urban freight system by authorities is important if they are to manage its development. Freight transport, however, receives limited attention from authorities compared to the transport of people [34], and authorities lack both awareness and competence concerning freight matters [29]. "The issues faced by the freight industry are still not fully understood" [29] (p. 93) and interventions by local authorities tend to be reactive. Despite the emissions from road transport, these are, to a large extent, missing from environmental action plans [31]. The lack of insights concerning freight matters among authorities also affects their goal setting and policy development. When authorities implement measures, they risk being counterproductive, since the consequences are not entirely recognized or understood [35]. Activities aimed at reducing the adverse sustainability effects of freight transport often fail due to unforeseen side effects, overlooked stakeholders [26], and underdeveloped economic consequence analyses [36]. Unclear governance and uncoordinated policy work risk making the change toward a fossil-free economy unstable and inefficient [37] because businesses do not know what to expect [2].

Barriers to fossil-free development are not just a matter for authorities but also concern business interests. Cargo bikes and electric vehicles could be acceptable fossil-free alternatives for urban freight transport, but several barriers prevent their wider implementation [20,38]. The current resource base of fossil technology and proven business models, low prices of fossil fuels, and weak support for new electric vehicles in present infrastructures are examples of such barriers. However, removing these barriers would not by itself solve the efficiency challenges faced in the urban transport system. Higher resource efficiency in urban freight transport would require other logistic setups with more modal shifts, micro-hubs, off-hour delivery spaces, and drop boxes [28]. The use of urban consolidation centers is one of the measures that has the potential to increase resource efficiency in urban freight transport [10]. New logistic setups would, however, require considerations regarding the economic effects for all stakeholders involved.

Economic feasibility is a pre-requisite for the long-term survival of initiatives, even if the actual purpose of new setups is social and environmental sustainability [39]. Viable business models are key to gaining stakeholder acceptance for new logistic setups [40], and economic viability is one of the main barriers [10]. Furthermore, new setups must be as competitive as present solutions and overcome the resistance to change among current actors [41]. The resistance of industry organizations can be a difficulty when proposing change to an urban transport system [2]. This is due to industry organizations representing members who, to a considerable extent, are negatively affected by any modifications to an existing system. The incentives for actors in the system to develop it are also affected by the externalization of societal costs of transport [42].

Another barrier to development is the complexity of the transition toward sustainable freight systems [43]. Such a transition requires a multitude of measures by different stakeholders with different time spans and a consideration of the relationships between the different areas and stakeholders within the system [44]. Cooperation between stakeholders is affected by the balance of risks and benefits of participating [45]. A transition requires coordination to function but also an adaptable approach to ensure that any issues arising along the way can be handled effectively [44].

3. Method

The ambition of this study is to provide a detailed picture of the barriers to fossil-free development from an urban freight system perspective. Therefore, this study focuses on one urban freight system and is designed as a case study [46,47]. Case studies have the ability to provide a rich description of a bounded system [48].

3.1. Data Collection

The data in the study were collected via semi-structured interviews complemented with document studies and a workshop. Respondents were enrolled from a variety of organizations which were active or attempting to become active in the urban freight system of the city in question. Individuals who were presumed to have strategic system insight were targeted. Three main sets of interview data were used. The first set of data was the basis for the study and consists of fifteen hour-long interviews with seventeen respondents performed in 2019. The interviews in the first dataset targeted equal numbers of officials from the city authorities and representatives of private companies active in the city, since public and private stakeholders were assumed to be able to contribute different and valuable insights regarding the system. These respondents represent a purposive sample based on certain criteria [46]. The interviews provided a rich picture of the situation but were not necessarily representative of all stakeholders. Access to potential respondents was gained via the city's transport network and a network of contacts from previous research. In 2021, the data were complemented with the second and third datasets. Dataset 2 consists of two interviews, similar to the interviews in Dataset 1, and aimed to capture complementary and updated perspectives on barriers in the system. This was also the purpose in creating Dataset 3, which consists of thirteen semi-structured interviews with senior staff focused on retail in the city. Datasets 1 and 2 comprise primary data collected by the authors. Dataset 3 consists of secondary data, which were collected in a study ordered by the city. Summarized data were shared with the researchers. A list of the respondents is given in Table 1. The process for the analysis of data is further described and visualized in the section on Data Analysis.

Table 1. Overview of respondents. Datasets 1 and 2 comprise primary data; Dataset 3 comprises secondary data.

Respon-dent No.	Data Set	Organization	In This Study Representing	Respondent's Role in Organization	Turnover [1] (MSEK)
1	1	City	Authority	Traffic planner	>5000
2	1	City	Authority	Business developer	>5000
3	1	City	Authority	Strategist	>5000
4	1	City	Authority	Strategist	>5000
5	1	City	Authority	Maintenance responsible	>5000
6	1	City	Authority	Traffic planner	>5000
7	1	City	Authority	Strategist	>5000
8	1	Retailer 1	Shipper, customer	Sustainability Manager	>10,000
9	1	Logistics service provider 1	Freight operator	Business developer	>10,000
10	1	Logistics service provider 2	Freight operator	Head of business area	>100
11	1	Logistics facility developer and owner	Stakeholder	CEO	>1000
12	1	Logistics facility developer and owner	Stakeholder	Regional director	>1000
13	1	Logistics service provider 3	Freight operator	CEO, founder	>10
14	1	Logistics service provider 3	Freight operator	Co-founder, Business developer	>10
15	1	Energy provider	Stakeholder	Business developer	>1000
16	1	Retail coordination service provider	Stakeholder	CEO	>1
17	1	Logistics data service provider	Stakeholder	CEO	>1
18 [2]	2	City property developer and owner 1	Stakeholder	Head of business area	>5000
19	2	Energy provider	Stakeholder	Business engineer	>1000
20	3	City property developer and owner 1	Stakeholder	Head of business area	>5000
21	3	City property developer and owner 2	Stakeholder	Property director	>1000
22	3	City property developer and owner 3	Stakeholder	Property manager	>10
23	3	City property developer and owner 4	Stakeholder	CEO	>100
24	3	City property developer and owner 5	Stakeholder	Property director	>100
25	3	Logistics service provider 1	Freight operator	Distribution area manager	>10,000
26	3	Logistics service provider 4 (waste and recycling)	Freight operator	Director waste and recycling	>100
27	3	Retailer 2	Customer	Store owner	>10
28	3	Retailer 3	Customer	Store manager	>10,000

Table 1. *Cont.*

Respon-dent No.	Data Set	Organization	In This Study Representing	Respondent's Role in Organization	Turnover [1] (MSEK)
29	3	Retailer 4	Customer	Store manager	>10
30	3	Retailer 5	Customer, shipper	CEO	>10
31	3	Retailer 6	Customer, shipper	CEO	>1
32	3	Retailer 7	Customer	CEO	>1
33	3	Retailer 8	Customer	Store manager	>1000
34	3	Retailer 9	Customer	CEO	>10

[1] Company group level, year 2020. Source: www.allabolag.se. Accessed on 5 May 2022. [2] Respondents 18 and 20 are the same person in different datasets.

The interviews were guided by a pre-defined interview guide and included broad open-ended questions concerning areas of interest. The interviewer had the freedom to adapt the focus of a certain interview to the situation, according to common practice [46]. The interview guide for Datasets 1 and 2 was developed from a review of barriers described in earlier research with input from three senior researchers from the fields of logistics, transportation, urban planning, and policy. The interviews in Datasets 1 and 2 were recorded and manually transcribed. Dataset 1 was complemented by the study of the policy documents mentioned in the interviews, such as a climate and energy plan, a quality-of-life program, and a traffic plan. Initial findings and impressions, after the first step of coding Dataset 1, were presented and discussed in a workshop with representatives from the city authorities. Eight senior stakeholders from the organization participated in the two-hour workshop, where the researchers and the participants debated the initial findings. The purpose of the document studies and the workshop was to allow the researchers to gain deeper insights concerning the case study by using multiple sources and to triangulate findings with initiated stakeholders [46].

3.2. Data Analysis

The analysis of data, visualized in Figure 1, was inspired by grounded theory [49], but a substantial amount of coding was carried out after the period of interviews.

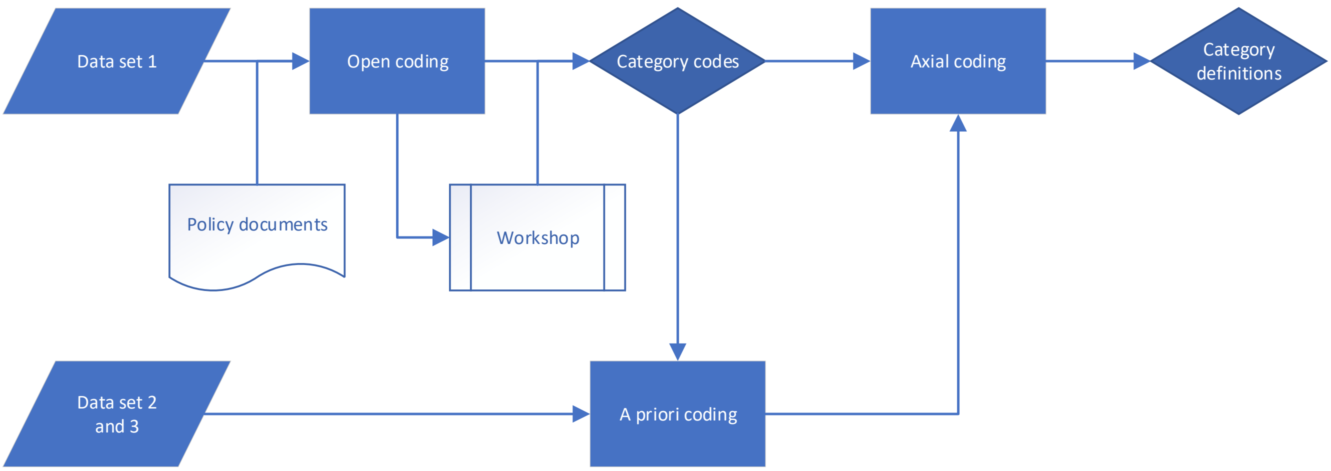

Figure 1. The data analysis process.

The analysis started with two steps of coding before the insights were summarized as results. The initial open-coding step was carried out with the purpose of allowing common themes across interviews to emerge from the data. In the analysis of Dataset 1, three interviews were test-coded by two researchers. The codes were compared, discussed, and mutually aligned before the rest of the dataset was coded based on the aligned codes. Cooperation such as this, between researchers in early phases of analysis, can help to triangulate and calibrate the perceptions of initial findings [46]. When all of the interviews in Dataset 1 were coded, the data were regrouped into categories based on the codes. In the second step, the axial coding, data were related within categories [49]. A pilot coding of one category, by both researchers, was used to calibrate results. After that, one researcher continued to code all other categories. As a last step, the same researcher summarized the insights of the second-order codes in every category. The interpretations of these summaries were then discussed and adjusted in several iterations between the researchers before the final version was agreed. Datasets 2 and 3 were analyzed using a similar procedure but with a priori codes from Dataset 1 for the initial categories [50].

This study also explores how the various categories of barriers are related to each other. The relationships between categories were analyzed in a process whereby mutual interrelations between all categories were identified. The insights from this process and the previous characterizations of barriers were combined with strategic planning theory [51,52], which was selected for its structure allowing the combination of stakeholders and processual aspects to develop societal systems in a certain direction. These insights were cross-fertilized with insights from the strategic change and management literature, thus providing established frameworks for the strategic management of change in corporations [53–55]. The theoretical inputs were used to construct a schematic model relating the identified barrier categories to one another and to the urban freight system.

4. Results

This study shows a variety of barriers in different areas related to the urban freight system that impede development toward a fossil-free system. Ten main categories of barriers were identified in the system. Each category consists of subcategories. An overview of the barriers is provided in Table 2. The barriers are further detailed in the following paragraphs.

4.1. Technology

Barriers in the category Technology concern uncertainties for stakeholders related to the adoption of new technology, such as electric freight vehicle technologies. Electric freight vehicles have different characteristics to traditional diesel-driven freight vehicles. These differences affect areas such as the driver and transport and route planning for logistic service providers, which, in turn, can affect both organizational and economic dimensions. If new vehicles have a more limited action range than traditional vehicles, measures which optimize routes and limit idling become more important. Technological novelties may also change infrastructural support needs, such as loading bays, charging or fueling stations, and hubs in cities, and create uncertainties for the potential users of the technology. Uncertainties regarding the availability of supporting infrastructure is therefore a barrier in the category Technology. The durability of newly introduced technologies is another area of uncertainty. While traditional fossil-fuel-based technologies in the system have been refined and proven over a long period of time, new and less mature technologies create greater uncertainty. For energy suppliers, the technological development of vehicles creates uncertainty about where, when, and in what volumes energy demands will occur. The difficulty of matching supply and demand for non-fossil fuels and electric energy is foreseen during a transition period.

Table 2. Overview of barriers to development toward a fossil-free urban freight system.

	Main Barriers in Categories
Technology	Uncertain consequences of technology in other areas (e.g., infrastructure needs) Uncertain durability of technology Uncertain availability of infrastructure for technology Uncertain availability of fuel and energy
Infrastructure	Difficult-to-predict needs External dependencies Uncertain availability
Economy	Uncertain outcomes of novel solutions Previous investments Short-term profit focus Externalization of the societal costs of freight Financial models for investments
Goals	Unaligned goals between stakeholders Unclear societal goals Unclear priorities between conflicting goals in the system
Policies	Weak support from policies Uncertain future requirements and support Unadapted policies
Organization	Long-term sustainability work in the city can be overruled by short-term political priorities Fragmented responsibilities for freight within the city authorities The city makes limited use of its influence to develop the freight system The power company organizations are unused to changes Many small freight operators with a focus on daily operations
Local politics	Uncertain dedication to achieving stated goals Operational decisions sometimes unaligned with long-term goals Perceived unpredictability by other stakeholders in the system
Cooperation	Stakeholders have different priorities Lack of forum for collaboration No common vision between stakeholders Low external pressure on stakeholders Unclear benefits for different stakeholders
Urban freight system knowledge and insight	Lack of freight system information (routes, volumes, etc.) Data are not mined for insights Unknown impact of freight system on society Uncertainty about how to combine business prosperity and achievement of societal goals
Societal factors	Rapid societal development makes long-term predictions difficult Increased freight capacity demands Changed characteristics of freighted goods

4.2. Infrastructure

Barriers related to infrastructure include external dependencies, difficulties of predicting needs, and uncertain availability. Local infrastructure is often part of a greater network controlled by other stakeholders. The long-term nature of infrastructure requires forward planning, and short-term, changing needs can be hard to handle. However, its availability can be vital for the usefulness of new technology. A challenging example, mentioned by both city and business respondents, is the current need for charger stations for electric vehicles—a need that is expected to have changed substantially again within ten years. The integration of infrastructure into networks means that the value of local infrastructure depends on the availability and capacity of the surrounding infrastructure and that local infrastructure can have more distant stakeholders, which limits the local mandate for decision making. One such example is the capacity for urban freight transport via the railway, which is limited by the capacity of the regional network and not controlled by the city. Another is the network for electric energy transfer, where a limited regional network capacity is reported to risk limiting the supply of energy within the city. Electric supply infrastructure development is characterized by long lead times. Furthermore, power supply must match demand at every moment. Spatial and temporal predictability is therefore essential. A large-scale introduction of electric freight vehicles threatens this predictability, since it will move the need for a power supply to new places and times with relatively short notice. The possibilities of pro-active measures to increase supply capacity in line with forecasts are reported to be partly legally limited. Additionally, quick charging, especially of heavy vehicles, results in high peaks of demand in the power grid, which are difficult for energy suppliers to predict in advance. This increased spatial and temporal uncertainty results in an increased risk for mismatches between electric supply and demand and could thus be a barrier to the electrification of the urban freight system. Another barrier is the possibility of the infrastructure being available but only to a few. One example is the infrastructure for unattended deliveries, which creates the possibility of optimizing loads and routes only if it is available for use by those actors who can use it to optimize their operations. Another example is provided by loading bays, where public bays are reported to have a lack of capacity, while private bays have excess capacity. This imbalanced use of infrastructure risks limiting the possibilities of optimizing the use of freight transport and becoming a barrier on the road toward a fossil-free urban freight system.

4.3. Economy

Several barriers on the route toward fossil-free urban freight systems can be found within the Economy category. Economic barriers concern the short-term focus of businesses on profitability, requirements for a return on investments, and the distribution of costs and benefits between public and private interests. Established businesses have invested in resources. They will fight to protect the value of these investments and to make their resources as profitable as possible. New investments must also normally be motivated in economic terms. If, for example, fossil-free freight vehicles have other characteristics than traditional vehicles, this affects work processes and organizations and risks generating costs for their adopters. Additionally, novel solutions, such as electric vehicles, are still unproven and risk becoming more costly and less beneficial than initially expected. Investments also need to be financed. Until now, fossil-fuel-based vehicle technology has required lower investments than fossil-free vehicle technology and its supporting infrastructure. Additionally, the development of fossil-free technology is perceived as more uncertain, which results in higher depreciation rates in business calculations. The effects of these rates are visible in, for example, the leasing costs for electric freight vehicles. Another identified barrier is obsolete pricing models, for example, for electric energy. The current model was built for a situation with predictable demand and a stable excess capacity on the supply side of the energy system. The main energy company in the city that is the focus of this study reports a development trend that is rather the opposite. Electric energy suppliers predict a supply side with both limited and varying capacity and a demand side with rapidly growing demand and high variations, which are difficult to predict even in the near future. In this situation, pricing models could become a valuable tool to create both stability in the system and more sustainable development, which would be beneficial for the development of a fossil-free urban freight system. The financing of infrastructure for electrification is another source of uncertainty. The business models for supporting infrastructure, such as charger networks, micro-hubs, and parcel lockers, are undergoing rapid development but are still maturing, and the durability of these solutions over time is still uncertain. Low profitability for logistic businesses is another component which encourages short-term focus. Businesses with low profitability have difficulty in focusing on and financing long-term investments. Finally, the data in this study show that the demand for strictly fossil-free and resource-efficient urban freight is low. Altogether, these factors demonstrate a focus on short-term profitability, which is a barrier to the fossil-free transformation of urban freight businesses. Another economic component is the externalization of the societal costs for transport from transport buyers to society. This means that the costs and thus the profitability of different freight choices for businesses is distorted, since the full cost of fossil-fuel-powered freight is not visible to its buyers.

4.4. Goals

The barriers related to the category of Goals concern the formulation and prioritization of a multitude of targets. One aspect is that many different goals exist for stakeholders in the urban freight system. The goals for society and businesses also differ, as do the timeframes. The results of this study show that politically decided societal goals relevant to the fossil-free development of the urban freight system are unclear and have not been operationalized. Uncertainty also exists regarding the political dedication to fulfilling strategic societal goals if conflicts of interest arise with respect to more short-term goals and with established businesses in the city. As a result, the connections between decided strategic societal goals and operational decisions on both the public and private company sides of the urban freight system in the city are vague and the interpretation of goals varies between individuals. The absence of a clear strategy to enable change in urban freight transport for better alignment with societal goals adds to the uncertainty regarding political dedication. City officials state, for example, that behavioral change is necessary to be able to achieve the strategic societal goals, but a common strategy to achieve this change in society is currently non-existent. Goals and strategies for the transition of the urban freight system to a fossil-free future could not be identified.

4.5. Policies

This category concerns the way policies support the development of the urban freight system. The main barriers are the weak support for development from present local policies and their uncertain future development. Implemented local policies do not enforce a development toward fossil-free urban freight in the city. Local regulations could support this type of development, but the political acceptance of this type of regulation is reported to be low. This uncertain future development gives businesses few incentives to invest in novel solutions and business models. Instead, it provides reasons to maintain already-existing investments, models, and resources and to maximize their returns. This is because investments in new solutions risk not fulfilling more clarified public and political requirements in the future. Another policy-related barrier is the uncertainty among officials concerning the legal possibilities of implementing certain policies, such as the Swedish Public Procurement Act, to support local societal goal fulfillment. The existence of rigid policies not adapted to societal or technological development is another aspect of this category of barriers. An urban freight system powered by electricity will require the development of the necessary electric supply capacity. One barrier to the proactive development of this capacity is indicated to be legal limitations, which hinder the proactive development of electric supply capacity and active demand management. Measures such as these could aid the ability to supply electric power in a resource-efficient way to an electrified fleet of vehicles at the times and places it is needed.

4.6. Organization

Organizational barriers refer to issues concerning the way the city and other stakeholders in the urban freight system are organized. Identified barriers concern uncertain management support, fragmented responsibilities, unused opportunities, and unadapted organizations and organizational focus. One barrier to the development of the urban freight system in the city is the strategic work of the city authorities being affected by political short-term priorities and uncertainties. This risks undermining long-term sustainable development initiatives within the urban freight system and creates uncertainty among stakeholders regarding priorities. For city officials, this also means uncertainty regarding support from their strategic managers for measures they deem to be beneficial when aligning the development of the city with the strategic goals. Strategic goals concerning emissions and the quality of life of the citizens have, for example, been politically decided but the delegation of the mandate to manage the development toward these goals seems unclear. City officials expect politicians to overrule their measures if conflicts of interest arise with established business interests. Another barrier to development is the city's organization around freight matters. The responsibility for freight matters is fragmented and split over several entities within the city authorities. This means that no entity within the city government is able to build more than fragmentary expertise in these matters. No entity has, for example, an overview of the area of urban freight in the city. Information regarding the status and development of urban freight transport in the city is, to a significant extent, missing, and few resources are available to change this situation. Another barrier to fossil-free freight development is the organization of the city's own procurement. In many cases, products are bought without requirements for fossil-free transport. Instead, supplier agreements are negotiated to include delivery to city entities. Products can then be called off by employees in the organization without incitements to coordinate or accumulate their purchases. These routines not only risk generating many small deliveries to entities within the city organization but also impede the overview of the urban freight transport used by the city itself and its resulting environmental footprint. Since the footprint is unknown, this results in a lower incentive to make improvements than if the impact had been transparent. Another aspect of the procurement is a reported fragmentation of freight transport service agreements. If these are negotiated per entity instead of at a higher level, transport routes risk becoming suboptimized. This disadvantages, for example, light electric vehicles more than fossil-fuel-powered vehicles since electric vehicles currently have more limited action ranges and are more sensitive to route optimization than fossil-fuel-powered vehicles. Another organizational barrier to fossil-free urban freight transport is identified within the structure of electric power supply. The functional electrification of freight vehicles in the urban freight system is dependent on the electric power supply. This supply is currently provided by local power companies, which have long been organized for a market with stable demand and excess supply capacity. Rapid changes to the demand side complicate stable electricity supply. Respondents in the study reported fears that power companies, unused to changes, will have difficulty in accommodating rapid development and less stable situations in their current organizations. Finally, several freight transport operators active in the urban freight system are small companies with limited possibilities of focusing on long-term development and matters beyond the company and its operations.

4.7. Local Politics

This category concerns how the political influence of the city authorities and their actions can constitute barriers to the politically decided visions for the development of the city. Barriers in this category are related to ambiguous political messages, short-term orientation, and perceived unpredictability. Local politicians can be seen as the top strategic managers of the city authorities. Political decisions have a considerable influence on the activities and focus of development. Local politicians decide on the visions and goals for the development of the city and guide the focus of the city's governmental institutions. This strong influence can, however, also hamper development in, for example, the area of urban freight. City officials state that more measures need to be taken with respect to urban freight if the strategic visions for the city are to be achieved. Despite this, the local political interest in freight matters is perceived to be low. This creates uncertainty regarding the political dedication to the achievement of set goals and the prioritization of long-term sustainable development, as conflicts of interest may arise through short-term political interests. The perceived political unpredictability and short-term focus which affects the urban freight system is in sharp contrast to the importance of forward planning and predictability identified by both city officials and company representatives as key components for the adoption of new, fossil-free solutions. Another barrier contributing to doubts concerning the political dedication to sustainable development is the political acceptance of externalities of urban freight transport in the city. This allows freight service buyers and service providers to focus on the direct economic aspects of their activities, while the indirect effects, such as environmental and societal costs, are handled by society. It also removes many of the economic incentives for businesses to develop solutions which are societally sustainable.

4.8. Cooperation

Barriers to cooperation concern reasons for stakeholders not to cooperate to develop a fossil-free freight system. Identified barriers are different focuses, priorities, and visions; low external pressure; a lack of discussion forums; and unclear benefits to the participants. The stakeholders in the system all have different priorities. While the city is focusing on its strategic goals and would like to optimize the system from a societal angle, the companies within the system have other aims. Their focuses are primarily company goals and optimization at a company level. No common platform exists which could be used to bridge the gap and create a common focus and synchronized priorities. For companies, the benefits of cooperating to optimize resource use and minimize environmental footprints are unclear. Cooperating with other organizations requires the investment of resources and might expose a business to risks. If the benefits are uncertain, the company might be better off if the investment is avoided. Additionally, the external pressure from both the city and business customers regarding the adoption of fossil-free technologies and reducing the negative footprints of freight activities in the city has so far been low. Potentially advantageous solutions, such as common deliveries, pick-ups, and waste transport, are thus not implemented. Individual predictions and visions of the future of the urban freight system in the city are additional barriers to cooperation. The strategic goals of the city are only vaguely connected to the urban freight system and its stakeholders. Thus, stakeholders create their own views concerning the future development of the system. These predictions differ regarding development directions and timeframes and make cooperation in the long-term development towards a fossil-free transition challenging.

4.9. Urban Freight System Knowledge

This category illuminates how lack of system insight among stakeholders can become a barrier to development. Identified barriers concern gaps in system insight among stakeholders regarding freight system status, its impact on society, data availability, and how changed requirements for urban freight can affect the development of the system and its stakeholders. The present status of urban freight in the city is, in several aspects, unknown (e.g., routes, volumes, frequencies, load factors, use of loading bays, and professional and private shares). Additionally, city officials and businesses within the urban freight system lack established channels for the exchange of information. Data that are available among stakeholders in the system are not mined for insights regarding urban freight transport, and strategies to bridge these gaps are not implemented. Facts concerning societal impacts, costs and benefits, environmental footprints, and other externalities of urban freight transport of different types and modes in the city are missing. This makes it hard to relate urban freight system development to the societal goals of the city. This lack of system insight among stakeholders also extends to the freight activities generated by the city's own needs. Another area where city officials indicate a knowledge gap is in the formulation of requirements for the stakeholders in the system. Among city officials, there is uncertainty about how requirements and policy packages can be formulated to combine both business prosperity and development in terms of societal long-term goals. The ambition of the city to be attractive for businesses was continuously reiterated, but the exact meaning of the expression appears to be only vaguely defined. This uncertainty among officials results in the reluctance of the city to formulate new requirements, since established businesses in the city may perceive these as negative.

4.10. Societal Factors

Societal factors concern forces in society surrounding the urban freight system which affect its development. Identified forces and barriers to development in the city are often related to general trends in society, such as digitalization, urbanization, and growing environmental concerns. The rapid digitalization of urban society means that the conditions for urban freight change swiftly. This makes, for example, long-term investments risky but also opens new opportunities for actors within the urban freight system. The emergence of online grocery sales and the further customization of delivery options might increase the demand for freight capacity to support these services. In combination with a focus on short delivery times rather than a minimized environmental footprint, this risks both lowering the fill rates in urban freight transport and delaying the introduction of a fossil-free fleet of vehicles, since the capacities of both traditional and new types of freight vehicles are needed. The study also shows another challenge in the city's development. In the city center, former shops are being converted into restaurants and cafés. This societal development increases the need for improved grocery transport to central locations and risks counteracting the development of light delivery vehicles and shared urban freight transport solutions. Other societal factors can, on the other hand, stimulate the development of fossil-free transport solutions. Citizens experiencing increased annoyance as a result of externalities due to fossil-fuel-powered, e-commerce-generated transport is one such factor. Another factor is the increased awareness among both senders, recipients, and citizens in general of alternatives to fossil-fuel-powered transport and the advantages these can bring to the urban environment.

5. Discussion

A more sustainable urban freight system requires a transformation to fossil-free practices and a general minimization of resource waste throughout the system. The purpose of this study is to contribute to the understanding of barriers and how these impede the development of urban freight systems. The system perspective, based on empirical data concerning the perceptions of several stakeholders in the same urban freight system, extends earlier research in which barriers were identified in delimited parts of urban freight systems. Many of the barriers discussed here have been addressed previously, but they were identified in different contexts and it was thus not possible to interrelate them. The design of our study enabled us to obtain a holistic view of the barriers and their interrelations in the urban freight system of one city. This resulted in the specification of ten categories of barriers. We will now discuss how these ten categories are interrelated and interact. Ultimately, this research serves to increase the city's possibilities of systematically addressing and overcoming the barriers to the fossil-free development of its urban freight system.

The relationships between barriers and the development of the urban freight system show the importance of system insight when designing strategies for change and measures to overcome barriers and move a system in a fossil-free direction. In order to obtain inputs for the creation of a structure which relates barrier categories within the system, we utilized the strategic planning, change, and management literature. This literature connects the areas where barriers are observed with development processes. It enabled us to identify different types of barriers and construct a schematic model, presented in Figure 2, which illustrates the types of barriers in one system. We suggest grouping the barrier categories into four types, based on their impacts on the development of the urban freight system: strategic, instrumental, implementational, and contextual barriers. Each type is detailed in the following paragraphs.

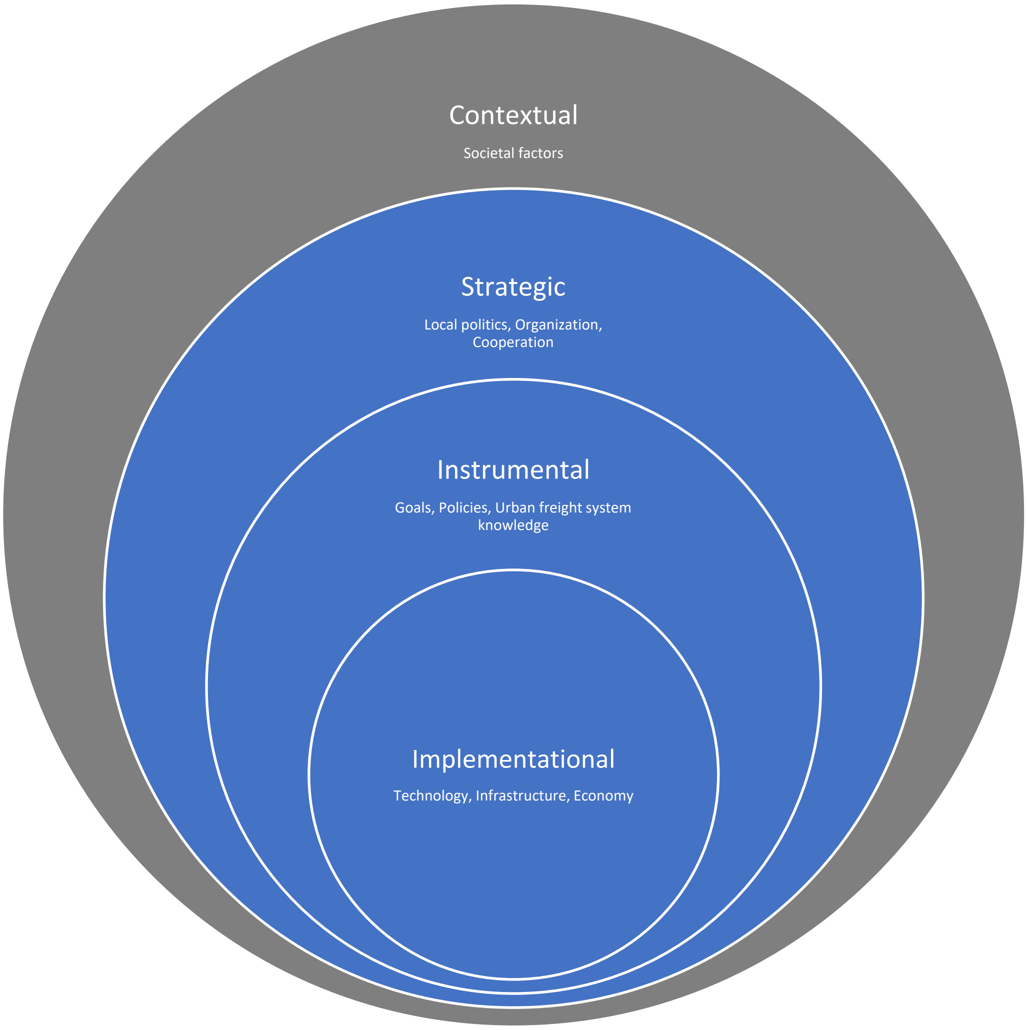

Figure 2. Barrier types and categories which impede the fossil-free development of the urban freight system.

5.1. Strategic Barriers

Strategic barriers prevent a change in leadership [54] and the sufficient involvement of stakeholders in the definition and prioritization of strategic issues [51,52]. In this model, the categories Politics, Organization, and Cooperation are included in this group. Strategic barriers are, from an urban freight system perspective, formed by the work procedures of the stakeholders but are relatively independent of instruments and implementation. The impacts of the barriers in this group are decisive. Politics and the way the stakeholders in the urban freight system are organized and cooperate build the foundations for the possibilities of transforming the system. The results in this study indicate the uncertainty of the city authorities concerning the support from the strategic management (i.e., local politicians) for measures deemed necessary by officials to enable the achievement of strategic goals. Additionally, the cooperation between the city authorities and private company stakeholders in the urban freight system was found to be limited, and forums for cooperation are lacking. At the same time, established businesses were expected by city officials to obtain direct access to politicians in cases of conflicts of interests, which in turn further increased the uncertainty among officials regarding strategic management support for their work. The political will to support logistic initiatives is decisive for progress [10]. Officials attempting to stimulate change through policies can face several challenges, one of which is the acquisition of local political support [56]. This study shows, also, that the cooperation between the city and businesses is limited. Well-established cooperation between stakeholders in the system is, however, deemed crucial by several scholars. The ability to cooperate can determine the effectiveness of new solutions which combine cleaner technologies and more efficient use of resources [27]. Increased cooperation between the stakeholders in urban freight systems can foster better understanding between the participants [9,57]. The lack of cooperation affects the possibilities of overcoming subsequent instrumental barriers, since cooperation, among other things, is a way of spreading knowledge [9]. The lack of cooperation, on the other hand, hinders stakeholders in the development of common perceptions. Disparate perceptions among stakeholders concerning both issues and solutions have previously been identified as barriers to change in freight systems [2,18,40].

5.2. Instrumental Barriers

Instrumental barriers impede sufficient change management [54] and mainly concern the instruments which can be used to support the execution of a strategic change. This group of barriers in the model comprises the categories Goals, Policies, and Knowledge. These are instruments which can be used to develop the urban freight system. They are formed by the strategic activities and set the conditions for implementation activities. This study indicates that a barrier to development is the insufficient operationalization of strategic goals. The plans and policies of the city include only vague formulations regarding freight transport, and only a few local policy measures stimulate change in the urban freight system. Local policies are not formulated sufficiently progressively to secure the success of local strategic goals. Knowledge is neither built to secure the quality of formulated goals and policies nor follow up on any progress. Previous studies have emphasized that the strategic goals and operations of public organizations must converge in one direction of development [56]. This study shows that, despite the existence of politically stated strategic goals, there is still uncertainty among city authorities concerning the legal possibilities of implementing measures to stimulate fossil-free urban freight transport. Furthermore, this study shows that the city conventionally buys goods that already include transport. This indicates a gap between goals (i.e., reduced emissions from transport) and operations (i.e., transport decisions left to suppliers) but also prevents the city government from collecting data and building knowledge even regarding the freight generated by its own procurement activities which the city could use to influence road transport [57]. A lack of data and therefore insufficient knowledge concerning the urban freight situation in the city was a recurring point brought up by city officials in this study. This lack of knowledge affects the city's formulation of policies and goals for urban freight transport. If data are missing, it is hard to use data to develop insights, support decisions, and develop freight systems [34,56]. Policies are a key tool to stimulate the development of urban freight systems toward fossil-free solutions [18]. However, the formulation of policies requires both legal and urban freight knowledge to avoid counterproductive measures [29]. In general, freight transport does not receive sufficient attention by municipalities [31,57]. This lack of attention and the insufficient use of instruments risks delaying the implementation of fossil-free solutions in urban freight transport systems.

5.3. Implementational Barriers

Implementational barriers prevent the execution of the strategic change to a fossil-free urban freight system. This group consists of the categories Technology, Infrastructure, and Economy. These barriers are closely related to operational decisions within companies and the city organization. The conditions for the operational group are formed through various instruments and strategic decisions. This study indicates that new technology is important for enabling a fossil-free system but that different dimensions of uncertainty can act as barriers to its acceptance. New and well-functioning vehicle technology is, for example, necessary for the reduction of freight transport externalities in urban areas [58]. However, even if the technology is available, various factors, such as insufficient business models and missing infrastructure, can slow down adoption [20], especially in situations where fossil fuels are relatively cheap and both infrastructure and other technological solutions are available due to sunk investments. The results of this study indicate that the private focus on short-term profitability, maximized return on investments, and the distribution of profits and losses between private interests and society are barriers to development of the system. Underestimating the importance of the economic effects to stakeholders in the system when trying to introduce new solutions in urban freight can be devastating for their long-term survival [10,39,40].

5.4. Contextual Barriers

Contextual barriers come from factors external to the urban freight system that affect the system but are unaffected by the system in vital ways. Societal factors are, for example, global trends, such as digitalization, globalization, urbanization, and climate change, which also affect urban logistics [20]. The development of these trends and their effects on the urban freight system must be continually considered when all other types of barriers are addressed.

5.5. Implications

The suggested schematic model and the system perspective on barriers within one urban freight system are the main contributions of the study. The schematic model provides a structure by means of which to understand the relations between development of the urban freight system and various categories of barriers within the system. This structure indicates that the order of efforts to overcome barriers can affect how effective they are for the development of the system. The system perspective on barriers within one urban freight system offers an overview of areas that need attention in change initiatives as well as insights concerning the various aspects of these areas grounded in the perceptions of several stakeholders in the system. Altogether, these theoretical contributions provide both overviews and detailed insights concerning the areas that need to be addressed in order to enable the development of a fossil-free urban freight system. These overviews and insights have not been available previously.

Structuring the barrier types and their relationships also has practical implications, not least as a support for leaders of change in society. This since the complexity of the situation can otherwise seem insurmountable and prevent action [7]. The suggested model shows that first focusing on strategic barriers in the process of change can provide important synergies for overcoming subsequent barrier types. Removing barriers to cooperation and finding the forms and forums which stimulate collaboration between politicians, city officials, and business representatives is likely to pay off in terms of better-informed and more long-term sustainable definitions of issues as well as feasible strategies which can help resolve these issues. These strategies can then be manifested in the development of goals, policies, and further knowledge concerning the aspects of the system among stakeholders. If the definitions of issues are clear, generally agreed upon, and the priorities set and manifested through various instruments, the conditions for removing the remaining implementational barriers are in place. On the other hand, addressing implementational barriers without first having addressed strategic and instrumental barriers will likely have a limited effect on the development of the system, since issues might not be fully understood by key stakeholders and instruments of various kinds may counteract the development.

Another implication of the suggested model of the system is that it illuminates the importance of finding methods and leaders to govern the system's development process, which involves multiple relatively independent stakeholders with different agendas. These agendas must be influenced and coordinated in order to contribute to the long-term development of the system.

5.6. Limitations and Further Studies

The exploratory character of this case study makes it important to continue to study barriers from a system perspective. This study is limited to the urban freight system of one Swedish city and the perceptions of stakeholders in that environment at certain times.

Studies of urban freight systems in cities of other sizes and in other societal contexts could reveal further insights about barriers and their relationships.

In the study, various types of freight were discussed, such as parcels and groceries. However, other types of urban freight are absent from the data, such as freight in construction, waste, and recycling flows. The studies of barriers from a system perspective but with a focus on certain types of goods flows could provide goods- and flow-specific insights concerning barriers to fossil-free system development.

In the results of this study, local politicians emerged as an influential stakeholder group. Their perspectives were not, however, included in this study. Adding these perspectives could offer new insights into barriers to development, especially into how politicians perceive their potential to deliver what is indicated as desirable in this study.

The productive use of strategic planning, management, and change theories in this study raises new questions. Though these theories primarily have an intraorganizational focus, they were still useful. Using other theoretical lenses with an interorganizational focus could support the development of further theoretical and practically useful insights concerning the governance of a purposive change toward fossil-free urban freight systems.

6. Conclusions

In this paper, barriers and their relationships to the development of a fossil-free urban freight system are addressed. This study adds to current knowledge by applying a system perspective on the barriers in one urban freight system based on empirical data on the perceptions of multiple stakeholders in the same freight system. It extends the knowledge of barriers and their interrelations and connects the barriers to the purposive change of the system in which they exist. Ten categories of barriers were identified and characterized, and their impact on the purposive development of the system toward fossil-free solutions was analyzed and discussed. The barriers span a wide range of areas and are interrelated. This illustrates both the complexity of purposive change of this system but also the importance of combining perspectives to capture various aspects of problems in the urban freight system. This means that barriers must be understood in relation to other barriers and the system in which they exist. It also demonstrates the importance of studying the barriers of a system from a stakeholder perspective, since stakeholders experience both different barriers and various aspects of the same barrier. When analyzing the barriers in a system, support from strategic planning, change, and management theories can provide a structure for examining the barriers and their relationships to each other. The barriers within the urban freight system considered in the study can be classified into three types in a hierarchy consisting of strategic, instrumental and implementational barriers. The system exists in an environment of contextual barriers, which are hard to change but which must be considered in initiatives aiming at overcoming barriers. Effective efforts to overcome barriers within a system begin at the strategic level and continue through subsequent levels. Directly addressing implementational barriers risks having only a limited effect on the development of the system. The insights gained are summarized into a schematic model showing four barrier types which in different ways impede the fossil-free development of the urban freight system. The insights summarized in the model have theoretical value and advance knowledge concerning the relationships between barriers and change and the urban freight system. The insights of the study also have value for practitioners, since these insights can support the prioritization of efforts that are effective from a societal point of view.

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