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An Analysis of Underused Urban Infrastructures: Usage Opportunities and Implementation Barriers for Sustainable Logistics

Larissa Schachenhofer *, Yvonne Kummer and Patrick Hirsch *

Institute of Production and Logistics, Department of Economics and Social Sciences, University of Natural Resources and Life Sciences, Feistmantelstrasse 4, 1180 Vienna, Austria; yvonne.kummer@boku.ac.at
* Correspondence: larissa.schachenhofer@boku.ac.at (L.S.); patrick.hirsch@boku.ac.at (P.H.)

Abstract: Motivated by the urgent need to discover innovative and sustainable approaches to address the strain on urban resources, this paper introduces a novel concept proposing the utilization of "sleeping assets". These sleeping assets encompass three distinct categories of urban infrastructures: neglected routes, idle real estate, and underused resources. By harnessing these assets, cities can alleviate the intense competition for land, traffic infrastructure, and parking areas. The findings presented in this paper are derived from an extensive literature study and expert interviews conducted with relevant stakeholders from Hamburg, Paris, Stockholm, and Vienna. Building upon the most pertinent insights from the literature and a structured content analysis of the interviews, we outline the advantages of employing sleeping assets for urban logistics initiatives. Additionally, we identify seven main categories of implementation barriers that must be taken into account. The results of this study reveal political and legislative barriers as one of the major impeding factors in initiating the utilization of sleeping assets. To address these barriers, this paper points towards crucial leverage for cities and provides an outlook on possible forms of sustainable urban logistics implementation. Thus, this work can support researchers as well as practitioners from city administrations and urban logistics interested in using sleeping assets by encouraging the exploitation of unused potential and avoiding particular implementation pitfalls.

Keywords: sustainable urban logistics plan; freight transport; innovative city logistics; underused urban infrastructure; logistics barriers

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1. Introduction

The process of urbanization and the growing demand for goods present increasingly complex challenges for the logistics industry. Sustainable development plays a pivotal role in the advancement of modern cities encompassing the mobility requirements of diverse demographic groups and securing a reliable supply of goods [1]. These two factors present fundamental human needs, yet they also pose significant challenges for urban environments. Urban centers are often characterized by traffic congestion, limited space, and environmental impacts, all of which can significantly affect the efficiency of goods delivery [2–4]. Furthermore, the rise in freight transport within cities exacerbates urban problems, such as delays in loading and delivering goods, noise emissions, and air pollution [5]. These aspects directly impact various aspects of human health and well-being. The OECD emphasizes the importance of urban transport in mitigating climate change [6] for two reasons: (1) road transport is the primary source of transport emissions in the European Union [7], and in most cities worldwide, it accounts for at least 30% of the total urban greenhouse gas (GHG) emissions [8]; and (2) the United Nations predicts that the global urban population will increase up to 68% by 2050 [9]. A French study has revealed that up to 50% of air pollutants (depending on the considered pollutants) associated to transport processes in cities are linked to urban logistics [10]. These issues

raise a critical question: how can we design sustainable urban freight logistics to meet the rising demands of modern society while minimizing the ecological footprint? In this context, the implementation of a "Sustainable Urban Logistics Plan" (SULP) plays a vital role. According to Eltis, the European urban mobility observatory, "A Sustainable Urban Mobility Plan is a strategic plan designed to satisfy the mobility needs of people and businesses in cities and their surroundings for a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles" [11]. The major objectives of an SULP encompass enhancing the efficiency and cost-effectiveness of passenger and freight transport; reducing air and noise pollution, GHG emissions, and energy consumption; and contributing to the overall improvement of urban environments for citizens, society, and the economy [11]. Despite these clear objectives, Hu et al. state that urban logistics planning is only being gradually integrated into the scope of urban planning, indicating a need for increased attention to this crucial aspect [10].

Moreover, within the urban setting, certain infrastructures experience greater strain than others. Recognizing and utilizing these underused resources represent fundamental steps towards innovative opportunities to meet the stated SULP objectives. A comparison of the average GHG emissions per ton-kilometer of the individual modes of transport in freight logistics shows that heavy goods vehicles cause significantly higher emissions than rail transport, inland waterway transport, and maritime shipping [12]. Nevertheless, in 2021, only 5.4% of all freight transport in the EU was carried out by rail and 1.8% by inland waterways [13]. Therefore, we see these infrastructures as currently neglected resources, especially in urban freight transport. Furthermore, vacancies pose a problem in terms of the efficient use of scarce urban space. It is not entirely clear how vacancies occur in existing buildings, for example, before they reach the final state of obsolescence [12]. Moreover, vacancies do not only occur in buildings, but can also be observed in car parks. Another area that has potential for increasing utilization efficiency in urban logistics is resources that are currently underutilized, e.g., all types of (partly) empty running vehicles for both passenger and freight transport. In this research paper, we refer to these resources as sleeping assets and define them as "urban infrastructures that are currently neglected or underused". Therefore, we have identified the following three main categories of sleeping assets in this study:

1. Neglected routes;
2. Idle real estate;
3. Underused resources.

The primary focus of this paper is the exploration of these sleeping assets and how they can be used efficiently in order to build more sustainable urban logistics systems. Our research aims are twofold: (1) to identify and assign sleeping assets to distinct categories for sustainable urban logistics; and (2) to analyze opportunities for their utilization and barriers to their implementation. By conducting a comprehensive literature review and in-depth expert interviews with relevant stakeholders from the cities of Hamburg, Paris, Stockholm, and Vienna, we thoroughly examine the multifaceted aspects and challenges that arise within this context. Drawing on insights gained from previous and ongoing projects, we discuss potential future advancements in this field, introducing innovative solutions that can enhance both the efficiency of urban supply chains and environmental sustainability.

The paper is structured as follows: Section 2 describes the material and methods underlying this study. Section 3 provides an overview of potential urban sleeping assets. By contextualizing the findings from the expert interviews with the key challenges emerging in the area of sustainable urban freight logistics, such as traffic congestion, limited space, emissions, and noise, we look at the different actors' perspectives and institutions involved in the design of urban logistics, as well as their varying requirements for the systems and resulting potential barriers to implementation. In Section 4, we discuss the findings in terms of potential uses and identified implementation barriers, as well as the role of laws, regulations, and policy frameworks that can help to promote sustainability and innovation in the sector. We conclude in Section 5 with recommendations for practitioners

and emphasize the need for a multi-disciplinary approach to make efficient use of dormant sleeping assets and achieve truly sustainable urban freight logistics. By addressing the challenges associated with the usage of urban sleeping assets and overcoming potential implementation barriers, we propose innovative solutions for building a more efficient, environmentally friendly, and resilient urban freight logistics system that will benefit both cities and their inhabitants in the long run. Finally, we summarize our main findings in respect to the defined research objectives and highlight areas for further research.

2. Materials and Methods

The applied methods in this study are depicted in Figure 1. The following section elaborates on the systematic approach used to analyze the potential of the efficient use of sleeping assets in cities.

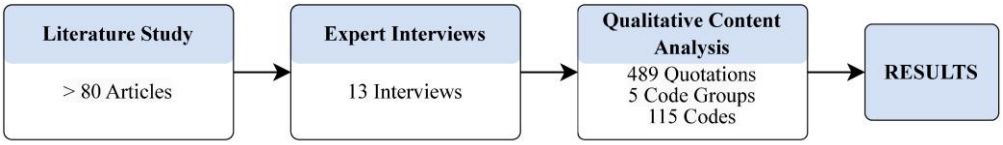

Figure 1. Applied methods in this study.

2.1. Literature Study

A comprehensive literature study served as a starting point for establishing a clear framework for the analysis of urban sleeping assets. Following Rousseau et al. [13], we divided the procedure into the four phases of identification, screening, eligibility, and inclusion. For our search of the scientific databases Scopus and Web of Science, we defined different keywords, such as SULP, sustainable urban logistics, underused urban infrastructure/resources, and innovation in urban logistics. For the literature study, we adopted the snowballing method. More than 80 articles were considered relevant to the topic, of which 19 were highly relevant.

Due to the scarcity of urban space and strained city infrastructures, the efficient use of existing resources as well as research on urban logistics continuously grow in importance. As shown in Table 1, we categorized previous works according to the sleeping asset categories.

Table 1. Chronological overview of key literature sources and allocation to sleeping asset categories.

Source	Year	Sleeping Assets Category			
		Neglected Routes	Idle Real Estate	Underused Resources	General
Trentini and Malhene [14]	2012			X	
Stenius et al. [15]	2014	X			
Österle et al. [16]	2015				X
Jellinek et al. [17]	2016	X			
Aljohani and Thompson [18]	2016		X		
Huo et al. [19]	2017				X
Dubeaux and Cunningham-Sabot [20]	2018		X		
Sirisawat and Kiatcharoenpol [21]	2018				X
Tannum and Ulvensøen [22]	2019	X			
De Langhe et al. [23]	2019	X			
Voegl et al. [24,25]	2019		X		
Ziegler [25]	2020			X	
Wang et al. [26]	2020				
Armstrong et al. [12]	2021		X		
Santos et al. [27]	2021			X	
Manchella et al. [28]	2021			X	
Russo et al. [29]	2021		X		
Bruzzone et al. [30]	2021			X	
Batarlienė and Bazaras [5]	2023				X

Research on neglected routes often addresses the potential of shifting freight transport activities from strained infrastructure to alternative routes using waterways [15,17,22] or railways [23]. Stenius et al. [15], Jellinek et al. [17], and Tannum and Ulvensøen [22] analyze the usage of waterways for passenger and freight transportation. While the first study [15] provides an approach for their adaption to urban environments worldwide, the latter two focus on cities in Norway [22] and Vienna (Austria) [17]. Based on a social cost-benefit analysis, De Langhe et al. [23] introduce a viability model for urban freight transport using railways. By applying the model to the city of Antwerp (Belgium) the functionality was illustrated.

Idle real estate is closely related to previous works on logistics sprawl and urban vacancy. Aljohani and Thompson [18] address the impacts of logistics sprawl on cities based on empirical findings, which highlight the longer travel distance of trucks due to logistics sprawl in European and North American cities. Other sources analyze the issue of vacancies. Dubeaux and Cunningham-Sabot [20] examine the potential of interim usage concepts for case studies in the German cities Berlin and Leipzig based on expert interviews. In contrast, Armstrong et al. [12] apply the quantitative vacancy visual analytics method to office buildings in the Australian city of Adelaide in order to address urban vacancy and evaluate the uptake of adaptive reuse as a problem solution strategy.

Underused resources, as the third category of sleeping assets, are closely related to passenger and freight transport integration. In this context, Trentini and Malhene [14] introduce a framework model to integrate the available infrastructure of passenger and freight systems for implementation in the French city of La Rochelle. Further research on this topic has been conducted in the course of a research project in Frankfurt (Germany) for parcel delivery using a tram [25]. Bruzzone et al. [30] propose key performance indicators to measure how integrated passenger and freight flows can improve social, environmental, and operational performances based on two case studies of Venice (Italy) and Velenje (Slovenia) and consider regulatory prerequisites to realize this approach. The findings of Manchella et al. [28] add to this field of research by suggesting a distributed model-free deep reinforcement learning algorithm for joint passenger and goods transportation. In contrast, Santos et al. [27] examine the value of collaborative solutions between transportation companies by assessing the costs and environmental impact using different proportional allocation methods.

Further key literature sources, which were allocated to the category "General", focused on barriers related to urban logistics. One paper analyzed local freight stakeholder involvement in sustainable city logistics innovation in the Italian city of Como. In the course of their work, the authors applied the logical framework approach to engage local freight stakeholders [16]. Other sources focused on barriers related to third-party and reverse logistics [19,21]. Huo et al. [19] examined integrative mechanisms of third-party logistics focusing on the impact of information sharing and process coordination based on data collected in China. In contrast, Sirisawat and Kiatcharoenpol [21] propose a methodology based on a fuzzy analytical hierarchy process and the fuzzy technique for order performance to prioritize solutions for reverse logistics barriers using the example of Thailand.

Batarlienė and Bazaras [5] conducted an online survey to identify opportunities for optimizing urban freight transport and its practical implementation. The authors' calculations reveal that traffic regulations and city road infrastructures significantly impact city logistics, followed by the city's geographical location and cooperation between the city administration and economic operators.

In addition to key sources, T. Ren et al. [31] present a comprehensive literature review of 306 published papers between 1999 and 2019 within the research field of green and sustainable logistics. The authors analyze the global evolution of this research field, provide a knowledge taxonomy of current research, and identify relevant research gaps. A recent paper by Vural and Aktepe [32] explores why innovations fail in urban logistics based on the example of collection-and-delivery points. The authors found the convenience of

existing alternatives, regulations, and security issues to be among the reasons for innovation failure in this field.

Most authors and presented works aim at identifying the challenges of specific projects and focus on one sleeping asset category. While cities differ in their problem context and starting conditions for solving these individual issues, patterns can also be derived and applied to other cities. Furthermore, urban environments and their underused resources should be evaluated holistically to present a conceptual framework that includes all categories which we consider as sleeping assets. Additionally, Ren et al. [31] point out that few studies focus on the success factors and barriers of implementing green and sustainable logistics from the perspective of social, environmental, and economic impacts. The presented paper adds to the existing literature by conducting a holistic analysis on underused urban infrastructures. It contributes innovative and relevant insights to the research field of urban logistics to increase the utilization of existing infrastructure and, thus, the sustainability of urban logistics systems.

2.2. Semi-Structured Expert Interviews

A total of 13 in-depth interviews were conducted with experts from Hamburg, Paris, Stockholm, and Vienna. The interviewees represented various city departments relevant to this research including urban development, urban planning, real estate management, and traffic. In addition, individuals from real estate companies, residential construction and management organizations, a consultant and academic expert in maritime and last mile logistics, and a representative from a chamber of commerce were interviewed. Furthermore, we engaged a person who had previous involvement in an innovative logistics project. The selection of interview partners was based on two objectives: (1) gaining insights into decision-making processes of city authorities and their perspectives on innovative logistics projects and unused potential of urban environments; and (2) obtaining implicit knowledge and experiences from individuals directly involved in the implementation of innovative logistics projects or occupying positions in which underused urban infrastructures are prominent.

Based on the findings of the literature study, we developed a semi-structured interview guideline. Simultaneously, we established an initial draft of the code system for the qualitative content analysis (see Section 2.3). It outlined the main topics and research objectives for the expert interviews. The questions and categories of interest, serving as a framework for the interview content, were formulated based on the empirical social research methods in Atteslander et al. [33]. The interview guideline consisted of eleven open-ended questions, with two optional extension questions included. The primary objective of these interviews was to gain insights into the perception of success factors and barriers in implementing innovative usage concepts for sleeping assets in urban logistics. We were particularly interested in drawing upon lessons learnt from previous projects, including pilot initiatives, as well as understanding the current state of ongoing projects. The interview guideline can be found in Appendix A. The interviews were recorded and transcribed.

2.3. Qualitative Content Analysis

For the analysis of the transcripts, the qualitative data analysis software ATLAS.ti was applied. We used the structuring qualitative content analysis as there is consensus in social research that this is the core method of qualitative content analysis procedures [34–36]. It allows us to answer explorative research questions [37] and thus was considered adequate with respect to the presented research aims. For the qualitative content analysis, we used Mayring's approach [34,38], which builds upon the concept of "the psychology of text processing" introduced in the early 1980s by Mandl [39]. Mayring's approach is recognized and widely used in German-speaking countries [40]. His work provides a clearly defined and structured analysis process. It is suitable for systematically processing and examining large quantities of text and was thus considered appropriate for the presented research. The

procedure aims at bundling and summarizing the content of texts. Mayring developed this approach further by suggesting working through transcripts line per line and documenting each work step in a table with the following columns: (1) quotation, (2) paraphrase, (3) generalization, and (4) reduction. These four columns represent the process of Mayring's approach, starting with the raw material, shortening the quotations by extracting the core statement, leaving any additional but irrelevant information aside, generalizing the message for its usage in the text, and reducing redundant text passages. The output of this analysis essentially allows us to make general statements about the problem context, yet it also provides important details and thus leads to relevant conclusions about interrelations between two or more codes.

A first draft of the code system assisted in formulating adequate interview questions with respect to the research aims. The final code categories were derived inductively based on the topics and transcript material and in accordance with the process model provided by Mayring [38].

We developed a code scheme consisting of 5 code groups and 115 codes in total. The code groups with respect to sleeping assets are as follows: (1) advantages, (2) barriers, (3) requirements, (4) sleeping asset types, and (5) types of usage concepts. The code groundedness, defined as the "number of quotations coded by it" [41], gives an indication about the relative importance of a certain code compared to the other codes of the code system and with respect to all conducted interviews. An overview of the complete code system and the codes' respective code groundedness are provided in Appendix B (Table A1).

Since the content of the interviews was confidential, the results of the analysis according to Mayring cannot be included in Appendix A. The analysis served to derive the following results and to explain them in the context of the findings from literature.

3. Results

This section presents the findings from the literature study as well as the results from the qualitative content analysis. Information on the identified categories of sleeping assets are provided, and different types of sleeping assets are assigned accordingly. In addition, implementation barriers and respective countermeasures are presented and explained. Usage opportunities and real-world examples are supplemented with our findings on the relative importance of each category and its associated codes, as well as the context discussed during the interviews. The sleeping asset categories presented in Section 1 were validated according to the results from the literature study and the expert interviews, as no new categories were revealed in the course of the research process.

3.1. Neglected Routes

Traffic congestion and the resulting rise in air pollution pose significant challenges in modern cities [42]. Consequently, there is considerable potential in diverting a portion of transportation to neglected routes. We define neglected routes as existing paths, tracks, and lanes that are currently underused. This includes underutilized waterways, such as rivers and canals, railways, and tram tracks, as well as bus lanes and other routes, whose utilization can alleviate the strain on congested sections and nodes of the road network. Utilizing waterways presents various opportunities to free up urban space. By using new paths and redirecting a share of freight flows to waterways, the transport capacities of traditionally used routes are supplemented, thereby reducing the burden on existing transportation systems [15]. An example of this approach is the Austrian research project "Radkombitransport (a German term for bike combination transport) (RAKO) Donaukanal", which explored strategies to combine urban waterways and the use of cargo bikes for the last mile. In 2016, when the project was finalized, a comparison between conventional road transport and the RAKO system showed only an 8.3% decrease in GHG emissions, primarily due to the use of diesel-powered barges. At the time, the utilization of electric boats would have incurred significant additional costs. However, alternative water-based transport forms are essential to achieving a substantial reduction in GHG emissions [17].

These environmentally friendly water-based vehicles represent energy-efficient transport solutions. A recent study by Ramirez-Villamil et al. [43] proposed sustainable network designs for a two-echelon distribution with respect to a barge utilized for parcel delivery. According to the results, the combination of water-based transport with e-cargo bikes resulted in a potential decrease in energy consumption by 92% and fixed costs by 41% [43]. Cities with access to waterways can significantly benefit from promoting water-based transport, as it can reduce the need for costly construction projects, such as tunnels and bridges [22].

Shifting a portion of road transport to rail presents another opportunity for using sleeping assets. De Langhe et al. [23] examined the viability of railway freight transport in three variations: (1) a tram dedicated to freight transport, (2) a passenger tram with a freight wagon attached, and (3) using a passenger tram for the transport of parcels. Their findings indicate that a freight wagon attached to a passenger tram yields more benefits than having a tram solely dedicated to freight transport. While the delivery of goods using a passenger tram is also a viable strategy, all three cases revealed that the socio-economic advantages of these concepts outweigh the benefits from a business economics perspective.

Table 2 shows the codes associated with the sleeping asset category neglected routes with a groundedness above 10 quotations and ranks them according to their frequency of use. *Infrastructural barriers* (26) is the most frequently used code associated with this sleeping asset category. The code *Inland waterways* (16) is second, while *Last mile distribution* and *Sustainability* are both coded 12 times, sharing third place. The code *Railways* is used 11 times throughout the transcript analysis, indicating that the topic *Inland waterways* came up frequently during the interviews.

Table 2. Code Groundedness with respect to Neglected Routes.

Code Name	Code Groundedness
Infrastructural barriers	26
Inland waterways	16
Last mile distribution	12
Sustainability	12
Railways	11

3.2. Idle Real Estate

The scarcity of urban space leads to increased prices for renting and acquiring real estate within city boundaries. This results in logistics sprawl, a trend describing bigger logistics facilities moving from inner urban locations to suburban and exurban areas. Consequently, freight vehicles have to travel longer distances, which negatively impacts the environment and employee commuting patterns [18]. Batarlienė and Bazaras [5] indicate that the challenges of urban logistics arise from the geographical location of cities and industrial and commercial facilities, as well as the distribution of centers that are often located in a city's periphery. These issues further give rise to challenges related to the last mile. Another observable trend is the rise in frequent low-weight freight movements. Thus, Aljohani and Thompson [18] suggest that traditional logistics companies should consider establishing small-scale logistics facilities closer to end customers. This approach would enable the use of environmentally friendly transport modes and reduce the number of freight vehicles in the city.

While finding adequate large areas within the city can be challenging, it is significantly easier to find so-called "residual areas", which refer to unused or underutilized spaces that constitute another main sleeping asset category, "idle real estate ". This category includes vacant buildings or areas in buildings, parking garages, parking areas, and other urban spaces with unused times, e.g., certain hours during the day or specific days during the week, when they could be used more efficiently. This sleeping asset category is essential because by maximizing the utilization of these idle spaces through temporary or interim uses, logistics actors can address the issue of limited urban spaces that meet their

requirements and are affordable. This, in turn, can discourage settling logistics facilities in cheaper suburbs and subsequently reduce travel distances to the end customers, fuel consumption, and emissions.

Vacant space can be addressed by establishing temporary or interim uses. Nevertheless, it is important to consider the impact of property law on land access [20]. Furthermore, while the adaptive reuse of empty areas may be an obvious solution, there is risk of missing opportunities for truly sustainable urban regeneration [12]. Therefore, it is crucial to enable logistics processes within city boundaries, facilitating the use of light electric vehicles (LEVs) and cargo bikes. Mobilizing idle real estate for urban logistics allows for the implementation of urban consolidation centers in various forms and sizes, promoting the widespread deployment of LEVs and cargo bikes for the last mile.

An example of such an initiative is the Remihub project in Vienna (Austria). This project utilized public transport areas, such as bus and tram garages, that were free during daytime, as a transshipment point for parcel deliverers. To reduce the number of trucks in the city center, cargo bikes were employed for transporting goods to end customers [44].

Table 3 shows codes with a groundedness above 10 quotations related to the sleeping asset category idle real estate. It can be seen that the interview partners associate certain difficulties with the use of idle real estate as sleeping assets, such as *Cooperation* (38) and *Infrastructural barriers* (26). In the case of *Available space* (18), it is of course also questionable whether they belong to the *Public space* (27) or are *Private spaces* (20). The *Scarcity of urban space* (18) was also mentioned several times as well as the term *Micro hub* (18), indicating another factor of relatively high importance compared to other codes. *Cargo bikes*, the *Location selection*, and *Transitory use* were coded 14 times, similar to the code *White label* (13).

Table 3. Code Groundedness with respect to Idle Real Estate.

Code Name	Code Groundedness
Cooperation	38
Public space	27
Infrastructural barriers	26
Private spaces	20
Available space	18
Micro hub	18
Scarcity of urban space	18
Cargo bikes	14
Location selection	14
Transitory use	14
White label	13
Efficient use of urban space	12
Last mile distribution	12
Vacant area (parking)	12
Areas for parking	11
Coordination	11
Mixed usage	11
Multi-story buildings	11
Noise emissions	11
Warehouse	11

3.3. Underused Resources

Urban passenger transport is characterized by both temporal and spatial peaks. There is also a certain variance in passenger numbers on different road sections. Between 1979 and 1998, various strategies were introduced to counteract these peaks. More information on these strategies, namely “short turning”, “expressing”, and “deadheading”, can be found in the literature [45–47]. Cortés et al. [48] examined the combination of short turning and deadheading, which made it possible to reduce the movements of empty vehicles and thus reduce operational costs.

In addition to these strategies to increase vehicle use efficiency in passenger transport, there are also approaches to reduce empty runs in freight transport, such as collaborative pick-up deliveries, collaborative collection, and collaborative cross-docking. Santos et al. [27] find that the application of these collaborative strategies could reduce global operation costs by 28% and global fuel consumption by 26%, leading to a significant decrease in CO_2 emissions.

While conventional concepts tend to focus on either passenger or freight transport individually, there is untapped potential in combining both types of transportation to maximize the utilization of empty vehicles. Trentini and Malhene [14] propose a flow-based model for the city of La Rochelle in France, which capitalizes on the available capacity in passenger buses to transport goods alongside passengers. Nuzzolo et al. [49] examined the use of outranged passenger trains for freight transport. They suggest using available infrastructures, such as designated spaces in public transport stations and railways, during off-peak hours to accommodate freight. By shifting from road to rail, their findings show a potential 5% reduction in road freight transport resulting in a 15% decrease in emissions and a 20% reduction in congestion annually in the Sorrentina Peninsula area of Italy. Scientists of the Research Lab for Urban Transport (ReLUT) analyzed the integration of a logistics tram in a pilot project that focused on parcel delivery services provided by courier, express, and parcel services (CEP). The existing tram network in Frankfurt, Germany, was utilized to transport parcels from a tram depot to a tram station in the city center where cargo bikes with special boxes were employed for further delivery. This approach offers an energy-efficient, fast, and flexible solution for delivering parcels to end customers. It is worth noting that public transportation stations with lower frequencies are better suited for such multi-purpose projects compared to highly frequented ones, as they facilitate uninterrupted loading and unloading. Additionally, it is important to consider that public transport service providers prioritize passenger transport over freight transport when using infrastructure primarily intended for passenger services to ensure uninterrupted passenger transport at all times [25,50]. Furthermore, recent research has introduced a deep reinforcement learning algorithm that integrates both passenger and freight transport. This innovative approach achieves a 30% higher fleet utilization and a 35% increase in fuel efficiency compared to other approaches that integrate passenger and freight transport as well as concepts that use vehicles solely for one of these two aspects [28].

For Table 4, the lower limit of groundedness had to be adjusted for codings above four times, as the codes related to the sleeping asset category underused resources were used comparatively little. This fact can be interpreted as an indicator of the relative importance the interviewees attached to the individual categories, but could also have to do with the interviewed persons and their respective fields of expertise. The topic *Last mile distribution* (12) came up most frequently compared to all codes related to underused resources. *Bundling of goods* and *Vicinity to (end-)customers* (9) were also mentioned several times. While the topics *Delivery areas*, *Integrating passenger and freight transport*, and *Usage conflicts* encompass relevant topics in terms of content, these codes were only addressed five times each during the interviews.

Table 4. Code Groundedness with respect to Underused Resources.

Code Name	Code Groundedness
Last mile distribution	12
Bundling of goods	9
Vicinity to (end-)customers	9
E-vehicles	7
User resistance	7
Accessibility	6
Delivery areas	5
Integrating passenger and freight transport	5
Usage conflicts	5

3.4. Implementation Barriers of Sleeping Assets

According to Eltis, the most important characteristics of a SULP are a long-term vision and thus also a clear implementation plan, a balanced as well as integrated development of all transport modes, and a participatory approach [11]. These factors correlate with our findings on favorable circumstances for the implementation of sleeping assets for urban logistics. However, the actual conditions are often very different, and many hinder the successful mobilization and use of these unused urban infrastructures in reality.

Our qualitative interview analysis identified some general implementation barriers and circumstances that need to be considered when implementing urban logistics projects. First, it is difficult to identify sleeping assets as such. The benefits of using them are not always obvious, and synergies are not recognized. For example, parking areas are not evenly occupied throughout the day or week, and waterways as well as other routes are not used for passenger transport throughout the entire day. There is a need to broaden their scope and include other uses.

In addition, communication is said to be crucial in every aspect, either to demonstrate benefits to users or to improve cooperation between stakeholders. Furthermore, user acceptance is often related to individual values and behavior. Therefore, raising awareness is important. To drive innovation, it is necessary to change the mindsets of relevant stakeholder groups. This is closely related to the barriers of user resistance. According to the interviewees, the implementation method itself is of great importance. Currently, many projects are being piloted to test real-life applications and make the case for scaling. All interview partners confirmed that it is easier to start with small projects and then apply them on a larger scale. However, the simultaneous implementation of numerous parallel pilot projects hinders the development of a unified solution. Moreover, the diverse range of services and urban areas necessitates adaptable solutions. Therefore, it would be beneficial to offer a catalog of innovative urban logistics concepts. In this context, the significance of simple logistics concepts was considered, but their true relevance is only evident when implemented on a larger scale. In addition to these general potential inhibiting factors, seven categories of implementation barriers are inductively identified. The following sub-sections address these identified barriers and elaborate on our findings on the three sleeping asset categories.

3.4.1. User Resistance Barriers

User resistance barrier encompasses various factors that hinder the positive acceptance of new concepts by users. One major cause of user resistance, as identified in previous research [21], is the lack of awareness and understanding. Our analysis of the interviews revealed that the social impacts of logistics are perceived very differently by stakeholders. On the one hand, logistics is seen as an independent and sustainable industry with minimal resistance from users. On the other hand, negative emissions and externalities associated with logistics create significant barriers to implementation, particularly in urban areas. Consequently, citizens, who are also users in the B2C sector, exhibit high levels of resistance, which pose an important implementation barrier for city logistics. In socially relevant projects, such as residential buildings or critical infrastructures, their justification and acceptance are based on the overall welfare of society. However, users often fail to recognize the need for and benefits of innovative logistics concepts, as the challenges associated with logistics are not readily apparent to them.

Wang et al. [26] identified persuasion and attitudes as key barriers that can significantly impact the acceptance of a new service. To effectively overcome these barriers, it is essential to adequately communicate and demonstrate the benefits and potential value for users. One effective countermeasure is to involve residents in the planning phase and highlight the need for the service and its associated benefits. The interviewees provided examples of successful projects in which participatory processes had yielded positive outcomes. They emphasized that the early engagement of residents was particularly beneficial for larger initiatives. At the same time, it is worth noting that other interviewees expressed skepticism

and questioned the necessity of resident participation, particularly in logistics projects that usually directly impact residents. Such skepticism suggests that involving residents might pose challenges in terms of reaching compromises and might hinder implementation efforts. Interestingly, one interviewee mentioned that users and residents often reject a new service during the planning phase but tend to view it positively once it has been implemented. However, acceptance greatly depends on the nature of the service being offered.

Further, communication between users and service providers is crucial to better understanding the users' requirements and provide a successful logistics service. Citizens' acceptance can be increased if additional services to the initial terms of use are offered. In addition to demonstrating the positive effects of a logistics service, amenities such as parcel receiving points, bicycle repairs, or discounts might improve the acceptance among residents.

3.4.2. Stakeholder Barriers

Stakeholders play a crucial role in logistics projects, and they can be categorized into three main groups: direct participants, indirect participants, and general stakeholders [51]. These stakeholders bring different perspectives and collaboration for the successful implementation of innovative logistics projects, as emphasized by all interviewees. However, it was noted that cooperation can be challenging due to competing interests among stakeholders.

Based on the triangle of social acceptance by Wüstenhagen et al. [52], which defines three main groups (socio-political acceptance, community acceptance, and market acceptance), Emodi et al. [53] analyzed the factors influencing these forms of acceptance. Market acceptance is mainly impacted by potential economic benefits, incentives, trust in government and industry, as well as perceived costs and risks [53]. In highly competitive markets, cooperation becomes more difficult. Companies naturally prioritize maximizing their own economic benefits, which might sometimes conflict with the interests of others. Additionally, logistics operators competing with companies in other industries, such as those utilizing sleeping assets, such as wastelands or vacant land, further complicate the situation. To address these challenges, one interviewee suggested that actors should specialize in their respective areas of expertise. This would help to avoid entangled structures and inefficient regulations from mixed responsibilities among companies.

When implementing cooperative logistics concepts, e.g., white-label solutions, it is also important to use synergies to increase the system's efficiency. Ndhaief et al. [54] implemented a simulation of logistics flows in cities using collaborative urban distribution centers. Their mathematical model coordinates maintenance and distribution strategies and minimizes costs by establishing collaborations [54]. In such concepts, the participation of all stakeholders can be crucial for success. Österle et al. [16] also identified the early involvement of stakeholders in the planning processes of innovative urban logistics projects as crucial for their success.

In summary, the opinions of the interview partners with regard to stakeholder barriers differed. On the one hand, cooperation is essential for the success of innovative logistics projects. On the other hand, it is a challenge to maintain communication and cooperation with all stakeholders and to overcome the barriers associated with the competitive market.

3.4.3. Financial Barriers

When it comes to financing logistics projects, fair conditions should be established first. Some interviewees talked about taking external costs of deliveries and fair working conditions into account in order to improve the reputation of logistics companies as well as to create profitable markets for innovative projects and companies. Suraraksa and Shin [55] developed an indicator for fairness among drivers according to the standard deviation of travel time and travel distance. The authors designed different scenarios in the context of fresh product distribution in Bangkok based on mathematical models. Their results show that an increasing number of distribution centers also enhances fairness among drivers [55], indicating that solutions must complement each other to achieve improvements on multiple

levels. A financial barrier arises when the initial and ongoing investments are high and relatively low return-on-investments can be expected [21]. In particular, small innovative concepts are under strong pressure from the competitive market and traditional logistics providers. The most important ideas derived from the interviews are the financing of logistics projects through funding programs or private companies. However, finding a functioning business model is challenging due to specific requirements, regulations, and the general market situation. Building sustainable business models that allow these concepts to continue beyond the funding period is crucial. This is currently seen as one of the most critical barriers to the broad establishment of logistics concepts outside of pilot projects. One issue mentioned in this context is the identification of additional benefits in the use of idle real estate or neglected routes. When talking about business models, the monetary return is usually decisive. However, utilization and efficiently used assets should also be valued.

3.4.4. Political and Legislative Barriers

Regulations, laws, and political agendas are crucial for innovative solutions to thrive. Urban logistics should be one of the priority "hot topics" on the political agendas of state and city authorities. Our analysis shows that the code "Political" was used 20 times and the code "Legislative" 46 times, making the latter to the most frequently used code in the course of our analysis. This reveals the importance of this issue for of the implementation of sleeping assets for urban logistics. The existing literature highlights that the absence of innovative urban logistics laws, guidelines, regulations, and comprehensive strategies from the government contributes to the persistence of sleeping assets and hampers successful implementation [19,21]. Several interview participants have emphasized the need for holistic strategies that encompass both the state and city levels. They recognize the potential of establishing an appropriate legislative framework to foster innovation in this field, support the initiation of pilot projects, and ensure the sustainability of these pilot beyond the funding phase. In addition, holistic policies should provide a clear vision for the future and anticipated legislative changes. This clarity would enable business owners to make long-term investments in their fleet, facilities, and other corporate assets, ensuring timely adaption to current and future needs without incurring unnecessary expenses due to an ever-changing political agenda and fluctuating regulatory regimes.

Further, these strategic plans can serve as a higher-level network that fosters collaborations among stakeholders, facilitating the exchange of ideas and joint strategy development. Several interviewees expressed the need for a comprehensive overview of past and ongoing projects, emphasizing the role of public institutions in assuming this. Furthermore, a lack of clearly defined responsibilities, which could be addressed in such holistic guidelines, is a prevailing issue. Industry-specific target definitions play a crucial role in structuring the implementation roadmap for entrepreneurs. Some interviewees also highlighted the inconsistency of guidelines within cities, making it exceedingly challenging to expand pilot projects beyond a niche scope on a larger scale. The absence of integration between city logistics and national and urban planning emerged as a significant barrier to innovation. Moreover, actors in cities mentioned the difficulty of introducing new concepts that deviate from the norm, further emphasizing the need for comprehensive policies. In the absence of clear regulations, companies face significant challenges in implementing innovative logistics concepts while maintaining competitiveness. Our interviewees revealed that current guidelines often lack practical applicability, leading to the generation of unused and underutilized areas. They also stressed the importance of proactive government support for innovative logistics concepts, including the consideration of financing aspects.

Once again, regular communication was mentioned as decisive in overcoming political and legislative barriers. In some cases, contradictory recommendations were made within individual institutions because their internal communication lacked efficiency.

3.4.5. Infrastructural Barriers

An essential barrier in logistics concepts is the existing and usable infrastructure. When considering different applications of infrastructures in urban areas, interviewees often mentioned conflicts of interests. Limited public spaces are primarily used for passenger transport, tourism, and recreation. As a result, these structures are tailored to these specific services and are often unavailable and unsuitable for logistics purposes. An interview partner emphasized that infrastructure originally designed for passenger transport (e.g., tramways, public transport facilities) is generally ill-suited for logistics operations. According to Sirisawat and Kiatcharoenpol [21], it is crucial to adopt a long-term perspective when considering the adaption of urban infrastructure, which in turn is closely tied to the political and legislative barriers.

Within this barrier category, the interview partners again mentioned the indispensable need to integrate freight transport and logistics in regional planning strategies. Only then can suitable infrastructure and specifically designated logistics areas be made available.

Furthermore, the coordination of residual areas with other forms of use is often a challenge. The appearance and design of logistics facilities are mentioned as necessary for their acceptance.

3.4.6. Technical and Technological Barriers

As mentioned earlier, the utilization of sleeping assets in logistics often requires technical adaption and technological development, which present various logistical and financial barriers. The use of alternative routes, for example, is acknowledged as highly complex and time-consuming. In terms of technical aspects, on-site equipment can significantly vary among service providers and usage forms. Due to these technical barriers, logistics companies find the interim utilization of idle real estate unattractive as they prefer assets that offer long-term planning security.

Technological barriers are related to information and communication technologies (ICT). Pokharel [56] highlights that the size of the company and the available technology are crucial factors influencing the adoption of ICT in logistics. When considering collaborative logistics concepts, it becomes necessary to harmonize ICT systems to ensure smooth collaboration among different companies. However, according to one of our interview partners, the challenge does not lie in making ICT systems compatible between different providers but rather in fostering a willingness to cooperate and establish interfaces. Companies face multiple barriers in adapting their ICT, such as high initial capital, administrative procedures, and information security [57].

Furthermore, an important barrier to cooperation is the issue of tracking and tracing. CEP service providers strive to offer a fully transparent supply chain. However, this objective may be hindered when using, for example, white label hubs. Digitalization and further technological advancements have the potential to address this challenge. Another technological barrier when it comes to the use of logistics concepts, e.g., smart loading zones, shared mobility services, or hubs, is the lack of a management tool. Interview partners experienced a lack of technological support, such as booking systems, in relation to these concepts.

3.4.7. Situational Barriers

Situational barriers include all factors that cannot be influenced, such as weather conditions and unpredictable fluctuations in demand. Although there is no opportunity to actively take countermeasures to overcome such barriers, their consideration is crucial when implementing innovative urban logistics concepts. To facilitate consideration, Laynes-Fiascunari et al. [58] proposed a framework for accurate traffic prediction on the last mile using dynamic data, such as real-time information concerning weather conditions among other variables, within their model. Additionally, Sgarbossa et al. [59] emphasize the value of real-time information for cloud technologies to schedule handling activities. Their demand-driven nature increases flexibility significantly, which could help deal with

situational barriers related to demand fluctuations from the utilization of sleeping assets as well. According to our analysis, waterways are most affected by this barrier due to water level fluctuations. Identifying this barrier helps in successful implementation, i.e., in the selection of suitable transport goods. Demand fluctuations can influence the sustainability of business models, especially innovative logistics concepts. Since the financial barrier as well as competitive markets are already crucial for companies when implementing such concepts, the integration of situational barriers should be considered in the planning phase to prevent failure.

3.5. Specific Barriers Related to Neglected Routes

During the interviews, the participants frequently associated the utilization of waterways in urban areas with various technical, technological, and infrastructural barriers. One key obstacle stems from the disparity in height between the water level and the quay, which necessitates specific equipment which can vary depending on the operator. This includes the provision and maintenance of such equipment, which can pose difficulties in the use of waterways. In addition, the nature of the cargo being transported must be taken into account, as time-sensitive deliveries such as refrigerated goods and food, are deemed less suitable for this type of transportation.

The decision to employ a certain infrastructure often depends on the available alternatives. As an example, one interviewee mentioned Utrecht (The Netherlands), where historical constraints on road transport have prompted the economic utilization of waterways. In conclusion, the effective use of waterways relies heavily on implementing technical adaptations, which are only pursued when waterways are recognized as valuable transportation routes. This also applies to railways, as the interviewees highlighted infrastructural, technical, and technological implementation barriers, such as differences in gauge systems, power systems, and signal systems.

3.6. Specific Barriers Related to Idle Real Estate

Several interviewees mentioned abandoned, unused, and vacant areas. In particular, the interviewees in the real estate sector had valuable insights into this sleeping asset. Vacant building areas were mentioned, but areas in public spaces, such as car parks, can also be described as unused or idle. Furthermore, wasteland, unused areas of public transport, underground areas, and water areas, which can be seen not only as infrastructure but also for the establishment of, e.g., a hub, were mentioned. There are different barriers within these categories. In many cities, the allocation of land specifically for logistics purposes is necessary. However, there is often a lack of dedicated space for city logistics resulting in conflicting interests with other sectors and companies. Consequently, the utilization of vacant areas heavily relies on urban planning and legislative specifications. The presence of competing interests and complex usage regulations contribute to the inefficient utilization of these properties. Moreover, due to the high demand and limited availability of urban land, real estate speculation becomes a concern. Renting spaces for commercial purposes tends to be more profitable than for logistics purposes. Therefore, while the city is expected to provide space, it only owns a limited number of real estate properties, typically subject to strict procurement guidelines, as mentioned by one interviewee. As a result, the city must apply indicators to evaluate businesses that wish to rent a space, often putting logistics companies at a disadvantage. This poses a significant barrier to innovative projects. Furthermore, Voegl et al. [24] evaluated the hidden dynamics between unloading actions, traffic flows, and parking practices of passenger cars. While loading/unloading areas contribute to successful urban freight transport, the authors state that conflicts of interest also arise when deciding to allocate public space for unloading areas instead of parking or pedestrian areas. Similarly, Russo et al. [29] found conflicting and common goals among stakeholder groups involved in a logistics hub designed for cooperative use, using a linear optimization model to propose an optimal allocation of the shared infrastructure. The model assumes that the hub's occupancy rate and convergent CEP user types lead to

an increase in utility. Ultimately, the success of such cooperative hubs depends on their alignment with the administration's and citizens' ideas for the future development of the city.

3.7. Specific Barriers Related to Underused Resources

The interviewees hardly mentioned any specific underused resources for city logistics. One prominent topic was the use of public transport for logistics purposes. In this context, numerous implementation barriers were mentioned. Firstly, the infrastructure and technical equipment of public transport, such as dimensioning areas and elevators, is not designed for freight transportation, as the main purpose of public transport is passenger transport. Secondly, its main purpose, the transport of passengers, should not be compromised by another use. Therefore, the use of public transport infrastructure should only be considered in off-peak hours. This approach offers multiple benefits. It optimizes the utilization of less busy time periods, resulting in enhanced synergies. Moreoever, by directly delivering goods to stores located in public transport facilities, the concept promotes sustainability. Additionally, during the interviews, one participant highlighted the legislative challenges associated with dedication. For instance, companies registered as public transport operators are not permitted to transport freight using their existing infrastructure. Furthermore, Bruzzone et al. [30] emphasize that the integration of passenger and freight transport is hampered due to governments' treatment of these flows as two separate systems. As a result, they are governed by different guidelines and regulations and thus overseen by different authorities. Nonetheless, Kim et al. [60] studied the combination of passenger and freight transport as an underground logistics system for parcels. The authors presented a mixed use of railway freight terminals and urban subways for the transport of parcels within congested urban centers [60]. In conclusion, it is crucial to harmonize these two services without compromising their original purpose. Therefore, the implementation of legal requirements and facilitation of flexible usages are imperative.

4. Discussion

This study identified three main categories of sleeping assets: neglected routes, idle real estate, and underused resources. Using these assets for city logistics can help to increase the sustainable flow of goods. Furthermore, shifting transportation from road to waterways or railways relieves congested urban road systems.

Based on our analysis, we have identified seven main categories of implementation barriers with respect to user resistance, stakeholders, financing, politics and legislation, infrastructure, technicality and technology, and situations that cannot be influenced. It is crucial to consider these barriers in their interconnected context. For instance, infrastructure barriers often coincide with technical and technological barriers. In many cases, the existing infrastructure requires adaption to meet the needs of logistics, and it may lack necessary technical devices for logistics processes. The provision of specific technical equipment is dependent on financial investment, necessitating long-term planning security for logistics providers. These interconnections illustrate the strong interaction and dependencies among the barriers. Nevertheless, addressing these barriers during the planning phase of innovative logistics concepts can significantly contribute to successful implementation. In addition to these aspects, the planning phase of such concepts frequently encounters resistance barriers from users. This resistance can be mitigated by (1) involving stakeholders, (2) effectively communicating the benefits of the logistics concept, and (3) offering additional services. By overcoming these barriers and successfully implementing logistics concepts, the reluctance of users and stakeholders can be diminished.

Furthermore, it is essential to address barriers related to financing, particularly due to a disparity between actual social costs and the visible costs associated to delivery services. This discrepancy fails to accurately reflect the true social costs incurred by such services. This factor plays a decisive role in determining the economic viability of implementing a sleeping asset model. It also represents a significant opportunity for state and city

authorities to effect change through legislation, creating economic incentives for the efficient utilization of available urban resources. Political and legislative barriers emerged as the most frequently discussed subjects during the interviews, indicating the great potential for establishing an appropriate legislative framework that fosters innovation in urban logistics. Consequently, it is crucial to continuously review and adapt existing laws. Engaging in a dialogue with practitioners is highly recommended to develop regulatory solutions that facilitate sustainable innovations in this field. Long-term planning and a comprehensive urban development strategy encompassing the integration of urban logistics serve as supportive measures in this regard.

Although most implementation barriers apply to all three categories of sleeping assets, some relate more to one specific category. For neglected routes, our interviewees saw the installation and maintenance of certain technical equipment as the main barrier. Cities or states could use this knowledge as leverage. By investing in such infrastructure, the use of neglected routes, such as waterways, can be promoted. Furthermore, expanding the infrastructure has the potential to significantly reduce the entry barriers for transportation operators to transition their operations to alternative modes. This, in turn, would enable a smaller portion of the route to be covered by road transportation. Several European cities have already implemented different usage concepts for neglected routes, demonstrating the successful shift of transportation from road to rail- or waterways. The reduction in infrastructural barriers and the increased utilization of waterways and railways also contribute to advancements in technology and techniques in this domain, gradually eliminating these barriers. However, it is essential to consider the sustainability of the chosen means of transport for these routes, such as the use of electric boats. Additionally, ensuring shorter distances to the end customer becomes essential to enable the use of LEVs or cargo bikes for last-mile distribution.

Important barriers in the context of idle real estate are related to property law and unclear property rights. In order to create good framework conditions for logistics actors, it is crucial to focus on enabling urban logistics within city boundaries in urban planning strategies, particularly the targets set in the respective SULPs. In addition, the dedication of urban areas under some national laws makes it difficult to re-designate land for logistical purposes in the short term. Integrated strategies both communicated and implemented by state and municipal authorities improve long-term entrepreneurial planning.

Previous and current approaches have demonstrated the feasibility of integrated passenger and freight transport. However, several barriers—infrastructural, technical and technological, and political and legislative—have been identified in relation to the implementation of underused resources. Streamlining the legislative process to facilitate the implementation of such concepts can serve as a catalyst for considering and initiating such projects in urban environments. Notably, leveraging public infrastructure during off-peak times or in specific sections with low passenger traffic holds the potential for achieving synergies.

5. Conclusions and Research Outlook

While cities face unique challenges, this research has identified common patterns, implementation barriers, and potential solutions for sustainable urban logistics. Based on these findings, we have assigned (partially) unused urban infrastructures to the three main groups of sleeping assets, namely (1) neglected routes, (2) idle real estate, and (3) underused resources. We conducted a comprehensive literature study and several interviews with experts from four European cities to examine the opportunities and implementation barriers associated with utilizing each category.

Within the selection process of the interviewees, we focused on cities that meet specific requirements, i.e., there is access to water, pressure on public spaces, and the political will to implement innovative logistics concepts, as well as people who have a broad knowledge of underused urban resources. Our primary focus was interviewing city authorities from different departments and real estate companies. We further recognize the value of enhanc-

ing our results by exploring different participatory approaches employed in innovative logistics projects and incorporating knowledge of best practice from them. Future research will expand the scope by engaging with interviewees from other European cities and cities from different continents as well as from multiple sectors to enhance the generalizability of insights. We mainly experienced constraints regarding the conducted expert interviews concerning participants' willingness and temporal availability. Nevertheless, in addition to the literature study, we conducted 13 in-depth interviews with relevant stakeholders. This allowed us to gain crucial insights from different perspectives on the status quo of sleeping asset utilization in cities and relevant implementation barriers.

The analysis revealed political and legislative framework conditions as one of the major impeding factors in initiating the utilization of urban sleeping assets. Thus, this paper points towards crucial leverages for cities. The adaption of legislative frameworks can facilitate sleeping asset implementation, fostering innovation in this area. In addition, the results underlined the importance of holistic strategies aligning state and city requirements with long-term political objectives to provide a clear direction for city logistics actors to set innovative actions for the sustainable transition and plan investments accordingly. Thus, this work is relevant for practitioners from city administrations and organizations, particularly but not exclusively urban logistics actors, as it can act as a guideline that reveals the untapped potential of increased sleeping asset utilization. Simultaneously, it encourages exploiting this unused potential and avoiding the pitfalls encountered in practice by outlining critical barriers that should be considered during project planning and circumvented during implementation. In this context, the present work constitutes another step towards developing sustainable city logistics systems.

Further studies can utilize the presented categorization of sleeping assets and the evaluation of implementation barriers for future case studies in urban logistics practice. This work presents a framework which (1) serves as a starting point for further studies in this research field, and (2) provides vital suggestions for urban logistics stakeholders intending to use sleeping assets within the scope of specific projects.

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Appendix A. Interview Guideline

Interview Guidelines for Guided Interviews in the ASAP Project Hamburg | Paris | Stockholm | Vienna

Format: Semi-structured interview (non-standardized, open questions)

Duration: about 45–60 min.
Focus topics:

- ➢ Sleeping assets, innovative logistics concepts
- ➢ Necessary or useful framework conditions and potential implementation barriers
- ➢ Potential user groups and acceptance of relevant stakeholder groups

Short project introduction:

Thank you for taking the time to talk to us! We are currently working within the framework of the research project ASAP "Awaken Sleeping Assets Project" on the identification of so-called sleeping assets—these are urban infrastructures that have not yet been used or have not been used efficiently, such as roads, railways, waterways, vacant buildings, and other urban spaces, but also vehicles that are not fully utilized. The advantages, disadvantages, and difficulties associated with the use of these are analyzed, as well as the logistical use for which the various sleeping assets could be suitable. The overall aim is to analyze the possible uses of such sleeping assets and their strengths/weaknesses profile in order to assess their potential role for the smart cities of the future. We would therefore also like to talk to you about innovative logistics concepts and projects in this field that you have already heard about or may even have been directly involved in. The interview will last max. 1 h. Your answers will be treated absolutely confidentially and will only be used for internal project processing. In order for us to make the best use of the information, we would like to record this interview. Do you agree to this?

- ➢ **Start recording/make handwritten notes**

Introduction to the content:

As already mentioned, we understand sleeping assets as urban infrastructures that have not yet been used or have not been used efficiently, and we are investigating their potential with regard to their possible use in urban logistics networks.

Entry (filter questions):

Filter questions based on direct or indirect experience and personal knowledge level:

(1) *Direct involvement and personal experiences;*
(2) *Indirect experience through stories told by colleagues or acquaintances, further education based on personal interests, following media reports, personal ideas, etc.*

No involvement→ Exclusion in advance or definition of emergency issues

Getting started with main questions:

- **How (highly) do you assess their relevance for the design of efficient urban transport systems?**
- **Are you currently involved in such logistics concepts or transport projects yourself or have you been involved in the past?**

- ○ **If yes:** Ask for details about the activity or projects;
- ○ **If no:** Ask for details on indirect knowledge, level of information and opinions in this regard.

Add clues to the questions on knowledge to help–e.g., where in the city, which infrastructures, which actors, why do you do it–so that you can prompt the interviewees.

Thematic area: Connection between Success and Implementation:

Are you aware of any particularly successful, innovative logistics concepts?

- ○ **If yes:** What factors do you think are or were responsible for this?
- ○ Why were they successful or innovative?

Do you know of projects in these or related areas that had problems with implementation or even failed?

- ○ **If yes:** Do you know what those factors were?
- ○ **If no:** What factors do you think could be decisive in preventing the failure of such projects?

What role do you think the simplicity of implementing such concepts plays upfront?

- In your view, what would be framework conditions that facilitate the implementation of such projects?
- In your view, what would be decisive factors for a sensible location where such or similar projects can be implemented?

Thematic area: Cooperation:

Do you have experience with cooperative logistics concepts yourself? ***(alternative question)***

- **If yes:** How was the operator concept of the cooperative logistics concept set up, which made cooperation possible?
- What advantages does it bring or did it bring?
- What disadvantages does it bring or did it bring?
- **If no:** What do you think are the possible advantages and disadvantages of cooperative logistics concepts?

Thematic area: Stakeholder Acceptance:

Do you (also) have experience with the involvement of relevant stakeholder groups in such or similar projects?

- **If yes:** How was the implementation approached and what communication strategy was used?
- How successful was the chosen approach?
- **If no:** Which factors would you generally classify as important in order to increase acceptance among relevant stakeholder groups?

Thematic area: Financing:

How relevant do you consider the financial aspect of innovative logistics concepts?

- Do you see possibilities to counteract potential barriers with regard to the financing of such logistics projects? If so, which ones?
- Do you also see a responsibility on the part of the city or the federal government to provide appropriate financial support?

Alternative or extension questions:

- **Are there any possible difficulties/obstacles/barriers that you see specifically in connection with certain forms of innovative logistics projects/concepts?**
- **We have already experienced XY in the course of past discussions. What is your experience with it or opinion on it?**

Closing question:

Are there any other suggestions you would like to leave us with in closing?

Inform again about the further course of the project and when and how (or if) the interviewee will receive further information.

Thank you for the interview! *Stop recording*

Appendix B. Code System

Table A1. Overview of Codes and Code Groundedness.

CODES	CODE GROUNDEDNESS
Abandoned infrastructure	4
Accessibility	6
Additional services	4
Aesthetic design	2
Affordability	6
Areas for parking	11
Available space	18
Awareness building	10

Table A1. *Cont.*

CODES	CODE GROUNDEDNESS
Best practice learning	3
Bundling of goods	9
Cargo bikes	14
Charging e-vehicles	4
Cities	10
Communication	2
Comparability	1
Compatible IT systems	3
Competition for land	1
Consignment tracking	1
Consolidation	3
Contaminated sites	1
Cooling boxes	3
Cooperation	38
Coordination	11
Cost efficiency	4
Delivery areas	5
Depollution	2
Difficulty	48
Digitalization	6
Efficient use of urban space	12
Enable direct transport	2
E-vehicles	7
Fair working conditions	5
Financial barriers	25
Focus on core competencies	2
Food delivery	6
Funding	5
Ground floor areas	2
Holistic strategy	7
Hub	10
Infrastructural barriers	26
Inland waterways	16
Innovation	28
Integrating passenger and freight transport	5
Inter- and Multimodality	7
Job creation	3
Lack of flexibility	3
Last mile distribution	12
Legislative barriers	46
Legislative control instruments	6
Light emissions	3
Loading zones	2
Local zoning	4
Location selection	14
Logistical vs. touristic use	2
Long-term planning	11
Micro hub	18
Mixed usage	11
Motivation	1
Multi-storey buildings	11
Municipalities	2
Noise emissions	11
Off-hour delivery	1
One-stop shop	1
Operational	4
Operator solution	3
Parcel boxes	16

Table A1. *Cont.*

CODES	CODE GROUNDEDNESS
Parking policy	4
Participation processes	12
Pilot study	8
Political barriers	20
Pollutant emissions	9
Practice vs. legislation	6
Private spaces	20
Public space	27
Public transport vehicles	1
Publicity	2
Railways	11
Renovating aging assets	1
Requirements	34
Residual areas	5
Scalability	4
Scarcity of urban space	18
Security requirements	5
Self-financing capability	10
Shared mobility	11
Simplicity	14
Situational	2
Staff mobility	1
Stakeholder barriers	32
State	2
Success factors	34
Supply network resilience	2
Sustainability	12
Technical and technological barriers	6
Time-bound use	6
Transitory use	14
True-cost pricing	4
Unclear property rights	1
Unclear responsibilities	2
Underground logistics	6
Urban planning constraints	4
Usage conflicts	5
Use of available areas	10
User group feedback	3
User resistance barriers	7
Vacancies	7
Vacant area (housing)	4
Vacant area (office)	2
Vacant area (parking)	12
Vacant area (public transportation)	7
Vacant area (retail)	3
Vicinity to (end-)customers	9
Warehouse	11
Wasteland	8
White label	13
Total Code Frequency	1031

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