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Usability of Physical Internet Characteristics for Achieving More Sustainable Urban Freight Logistics: Barriers & Opportunities Revealed by Dominant Stakeholder Perspectives

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ABSTRACT

Urban freight logistics currently has to deal with multiple unsustainable conditions. Physical Internet (PI) characteristics can be promising to make urban freight logistics more sustainable. This paper explores the opportunities and barriers for implementing this concept. Q-methodology is a method to reveal the different stakeholder perspectives. The results of the Q-methodology show four different perspectives out of which three perspectives show a positive attitude towards PI characteristics. One perspective is more moderate and states that a lot is possible already without any changes happening. One of the barriers shows there is no urgency to change. Further, most perspectives have a positive attitude towards regulations as long as they are nationally coordinated. On the basis of these results, policy recommendations are developed that state individual and collaborative actions for stakeholders.

Keywords: Physical Internet, Urban Freight Logistics, Q-methodology, Sustainability

INTRODUCTION

The current logistical system is described as unsustainable in an economic, environmental, and social way (1). Mervis (2) states that the logistical industry is a conservative industry that, because of this attitude, is now dealing with unsustainability symptoms. Since urbanization is a prevailing global trend (5) this part of logistics becomes increasingly important. Key problems in urban freight transport include:

- shipping a lot of air and packaging;
- a large share of empty trips;
- social exclusion of drivers;
- massive congestion blocking supply chains;
- smart automation and technology being hard to justify.

These symptoms have prevailed for decades and appear to be unavoidable and irreparable (3)(4).

Besides stating unsustainable developments in the current logistical system, Montreuil (1) introduces a promising concept to deal with the so-called 'global logistics sustainability grand challenge'. This concept is called the 'Physical Internet (PI)', 'a global logistics system based on the interconnection of logistics networks by a standardized set of collaboration protocols, modular containers, and smart interfaces for increased efficiency and sustainability (6). This concept also appears as a strategy in the roadmap for long-term logistics innovations in Europe (7) and the towards zero-emission city logistics in the Netherlands (8-9). Both were built up in recent years through an open, multi-stakeholder, iterative consultation process.

A literature review conducted in the PI domain by Sternberg (10) assessed the quantitative research done on the effects of PI implementation and these show promising results (11-13). There already are solutions in urban freight logistics that make it more sustainable but PI concepts are currently not in use. The literature review of Treiblmaier (14) in the PI domain shows that the majority of research conducted is quantitative or conceptual and only a small amount is based on surveys (7%) and case studies (3%). Consequently, little is known about stakeholder perspectives regarding PI in urban freight logistics. However, it is an important aspect since the PI will change the way decisions are made in the system, which has a direct effect on the stakeholders (15). Due to this literature gap, it is not clear whether stakeholders in urban freight logistics find a logistics system with PI implementation equally promising (10).

Since PI is currently not in use barriers to implementation can exist. In general lack of innovation in the logistics sector (2) and a paradigm shift in decision making are named (15) as barriers. Simmer (20) also identified barriers with Austrian LSPs. However, urban freight logistics is characterized by a multitude of stakeholders. Barriers can differ between those stakeholders. PI is a promising concept that can attribute to the sustainability of urban freight logistics. Sustainable urban freight is the goal so it interesting to reveal opportunities next to the identified barriers.

- *What opportunities and barriers exist for the implementation of Physical Internet characteristics in urban freight logistics and how can they be used/avoided to move to more sustainable urban freight logistics?*

To answer this question first a literature study is carried out on PI, and PI in Urban Freight Logistics. The following section explains the research steps in the Q-methodology. Further the results obtained by the application of the Q-methodology in the Netherlands are discussed. The next section shows the main obstacles and opportunities for PI and discusses a policy environment for implementing PI. The paper ends with the main conclusions.

LITERATURE STUDY

This literature study focuses on the PI-concept and PI-concept in an urban freight logistics context.

Physical Internet

The Physical Internet is a vision that could fundamentally change current logistics operations (1). Montreuil (17) even thinks that 'we face a revolution as radical as the Internet Revolution'. Ballot (6) defines the Physical Internet as 'a global logistics system based on the interconnection of logistics networks by a standardized set of collaboration protocols, modular containers and smart interfaces for increased efficiency and sustainability'. The definition of PI can be ambiguous since multiple definitions exist in literature. To deal with this uncertainty, the characteristics from PI named by Montreuil (1) are compared to the definitions of Ballot (6) and Treiblmaier (14). Based on the comparison the most important characteristics of PI are defined as followed:

- Open system
  - Data sharing
  - Asset sharing
- Standardization
  - Standardized collaboration protocols
  - Standardized modular containers

In a PI-environment, stakeholders get different roles as well. When looking at the characteristics of PI it becomes apparent that PI is strongly dependent on sharing of both data and assets. Data, like the shipment's origin and demand, should be available centrally (and safely) to make flow optimization in the network possible. The network exists of physical assets, like different kinds of vehicles, warehousing facilities, and transshipment points. These are indeed part of the open system creating a network with multiple options for optimizing freight flows. The foundation of this system lies in both standardizations of packaging and data collaboration protocols.

The PI should realize the shift from a private supply network to an open supply network (1). This steers towards outsourcing logistics, or at least, not merely taking care of your own. According to Crainic (18) 'the retailers and manufacturers do not anymore exploit their dedicated distribution centers'. In this sense, a Logistics Service Provider (LSP) is an appropriate stakeholder to take care of those logistics services operating in an open supply network. The shippers move their goods through the open supply network. This means that different links and hubs can be used regardless of the logistics service provider that operates that part of the network. In the current system, the logistics service provider defines the routes and their options to improve are limited in this private supply network setting (1). It is interesting to see how LSPs feel about this paradigm shift. Simmer[1] (20) shows that in Austria logistics companies are mostly positive towards horizontal collaborations. However, they see barriers like the fear of antitrust fines and high administrative input. Simmer (20) argues that the first steps towards collaboration as proposed in the PI vision are horizontal collaborations. Therefore, LSPs can have a very important role in the shift to this new logistics system. Eventually, shippers can obtain more decision power, but this can only happen when LSPs start to connect their private supply networks.

Physical Internet and Urban Freight Logistics

Crainic (18) linked PI to urban freight logistics in order to reveal the possibilities of this novel concept for the final distribution stage. PI aims at a structure with multiple hubs that are all linked to each other. This can be translated to urban freight logistics by using (already existing) hubs for consolidated city distribution. These hubs do not necessarily have to be located at the outskirts of urban areas while PI also allows flows to be consolidated in an earlier stage.

The key to the concept is that not all different cities are treated as unique. The PI concept relies on standardization which can only be beneficial when used on a bigger scale. Besides, the major users of

[1] Horizontal collaboration is between companies in the same industry that, while not competing directly, market and sell to similar customers and consumers. A high-profile example of horizontal collaboration involves the Hershey Co. and the Ferrero Group in North America.

the logistics system do not only serve a single city. This is why the interconnection with other cities is 'a fundamental key' for the PI concept in urban freight logistics (18).

The operationalization of PI in urban freight logistics can also be connected to the UCC (Urban Consolidation Centers) or Urban Freight Hubs (UFH) developments that can currently be observed. Besides, the use of PI characteristics might even break down certain barriers that current concepts have to deal with. Some of the barriers to the economic feasibility of UCCs could diminish in combination with a PI-based system. Fragmented cost savings will not be a problem since PI is based on fragmented supply chains. In PI it is also easier to achieve a certain critical mass, as PI is inherently not limited to a single urban area and a small amount of participants.

On the other hand, with a system like PI, it is questionable if a dedicated UCC still has a future. In an open supply network, multiple existing DCs surrounding urban areas could act as urban hubs in the PI network (1, 18). Shipments could be consolidated and shipped inside the urban area with zero-emission vehicles. Besides, in the current situation, the zero-emission vehicles belong to a certain UCC. Combining private supply chains then forms new private supply chains within the urban areas. Whilst in a PI network a vehicle should not merely be in use for a single hub but for all the hubs in a network of open supply chains.

According to Montreuil (1) PI has the potential to resolve all of the three overarching types of unsustainability issues. However, it is difficult to implement such changes to the vast logistical system that is currently in place. The PI proposes fundamental changes to the basis of how logistics function right now. However, it is difficult to implement such changes to the vast logistical system that is currently in place. Most of the research that is done is conceptual or quantitative and focused on design – there is no qualitative empirical research which identifies stakeholder perceptions of PI in urban freight logistics as major innovation (14).

Q-METHODOLOGY

Q-methodology is an exploratory technique (22) based on gathering information from different stakeholders in a certain area of interest. The information is retrieved by constructing a survey that entails rating statements regarding the subject relative to one another. The statements are retrieved from different sources and should represent the discourse of the topic. Q-methodology operates on the assumption that on a certain topic, there will only be a limited number of distinct coherent viewpoints that one can have, which tend to be shared by groups of like-minded stakeholders—so-called 'finite diversity' [31,32]. Therefore, the sampling process is purposive rather than random—focusing on including organizations that can be expected to have differing viewpoints, as explained above—and the sample size does not have to be large: A general rule of thumb is that the number of participants should not exceed the number of statements in the Q-set [9]. The following stages are part of the Q-methodology.

Q-set

The first step in the process is the creation of the Q-set. This set (**Table 2**) consists of statements about the implementation of PI characteristics in urban freight logistics. These statements originate from literature research - on both scientific and grey literature - and interviews conducted with experts. The group of experts was composed of researchers, policymakers and logistics entrepreneurs with knowledge of both sharing logistics (or PI) and urban freight logistics. The interviews were conducted by telephone in a semi-structured way, since the amount of knowledge about PI differed between interviewees. The questions were tailor made and related to sustainable urban logistics, physical internet and the combination of those topics. In the interviews the interaction of those topics with their own activities was discussed. Further, also their view of these topics related to a more aggregated view of the logistics market came up.

The statements are based on reviewed information from all the different sources. This means that statements are not specifically linked to a single source. The main aim of the statements is to represent the observed angles. Finally, the Q-set is validated by a couple of interviewees.

TABLE 2 Q-set on PI characteristics in Urban Freight Logistics

#	**Q-Statement**
1	Sharing assets in urban logistics are very complicated due to an abundance of client-specific services that are currently offered.
2	Sharing distribution centers on the outskirts of cities will remove the need for urban consolidation centers.
3	Increased efficiency by sharing assets increases city liveability more than changing to zero-emission vehicles in urban freight logistics.
4	The hidden costs in logistics make fair assignment of costs and benefits a major barrier for asset sharing concepts.
5	Even the introduction of road pricing in urban areas won't increase the level of asset sharing.
6	Most logistics service providers have the will to share assets but the transition costs currently do not outweigh the benefits.
7	Strong long-lasting client relationships cannot be sustained with a system based on asset sharing.
8	Most logistics companies are not digitally ready for data sharing while they should be.
9	When data sharing proves to yield significant economic benefits suddenly most of the logistics service providers are able to do it.
10	When data is shared on a large scale the bigger companies are mainly going to benefit from it.
11	A disruption in the logistics sector is needed to make companies share their data.
12	Some say the fear of sharing competitive information is a big barrier to sharing data but in reality, this isn't the major problem.
13	Urban freight logistics is already quite efficient and does not form a very urgent problem otherwise there would be more regulation already.
14	The introduction of zero-emission zones will exclude the smaller logistics service providers from the urban logistics market.
15	Zero-emission zones are going to provide low emission logistics but will increase total vehicle kilometers.
16	The biggest inefficiencies in urban freight logistics are caused by shippers and receivers taking care of their own transport.
17	The reason why shippers and receivers provide their own transport is mainly that they do not see it as extra costs
18	Although the margins are small the logistics sector is not being challenged enough to get more efficient.
19	Municipalities should regulate urban freight logistics more to tackle unsustainable issues but it should be nationally coordinated.
20	Pilots that are done to improve urban logistics are mostly executed with small volumes and have a small chance of succeeding.
21	Municipalities say they want to make urban freight logistics more sustainable but mostly because it looks good.
22	A governmental organization should be in charge of a standardized data-sharing platform.

23	An open platform where logistics service demand and supply meet will exclude a lot of logistics service providers from the logistics market.
24	An open platform where logistics service demand and supply meet will be the future of logistics.
25	An open platform for assets sharing will improve efficiency but will ultimately result in a decrease in urban liveability.
26	An open platform for asset sharing causes better competition instead of forming a monopoly.
27	Differences in data formats on loading units are currently a major barrier to asset sharing.
28	Size standardization of smaller loading units will accelerate the sharing of assets.
29	The current level of loading unit standardization in logistics is adequate for sharing assets.
30	Standardization of smaller loading units should be introduced by a governmental organization.
31	Standardization of smaller-sized loading units will lead to higher load factors, especially in urban logistics.
32	Postponing certain emission restrictions in urban areas from 2025 to 2030 is needed to keep urban freight logistics affordable.
33	The current level of data format standardization is generally sufficient for the sharing of assets.
34	Municipalities should obligate data sharing, just like the obligation to use zero-emission vehicles in the future.

P-set

The participants of the Q-analysis are defined in the P-set. In this set, multiple stakeholder groups are represented that are related to urban freight logistics. Our P-set contains 15 logistics service providers, 2 branch organizations, 8 municipalities, and 3 other organizations. From those organizations one person in a managing position participates. Ultimately, 28 participants take part in this research which proved to be sufficient to extract significant perspectives.

TABLE 3 P-set including details of actor groups

P-set	**Details**
15 Logistics service providers	Various LSPs based on their core business; parcel logistics, perishable goods logistics, city logistics, and retail logistics.
8 Municipalities	Large and medium-sized municipalities (for the Netherlands, these are between 40,000 and 800,000 inhabitants)
2 Industry associations	An association for logistics service providers and one for trade and production companies dealing with logistics.
3 Other	A national governmental organization, a provincial governmental organization, and a company specialized in the standardization of supply chains.

Q-sort

As previously mentioned, the statements (Q-set) are presented (**Table 2**) to the participants (P-set) in a specific format. An example of a Q-sort format can be found in **Figure 1**. Thus, the more extreme options (-4, 4) have the lowest amount of space for placing certain statements. On the other hand, the most neutral opinion (0) has the highest amount of space for placing certain statements. This format

imitates a normal distribution and forces participants to rate statements in comparison to each other and make trade-offs (23). Participants use a browser-based tool (KADE v1.2.0) to rank the statements.

-4	-3	-2	-1	0	1	2	3	4
15	34	33	32	2	9	24	16	31
25	13	23	3	12	1	4	28	30
	18	7	6	5	14	22	19	
		21	10	26	11	17		
			8	29	27			
				20				

Figure 1 An Example of a Filled out Grid used for the Q-survey, the Numbers Represent Statements. (KADE v1.2.0)

In this research, a balanced grid is applied as it is expected that the participants have both knowledge of - and an opinion about - most of the statements. To explain the research and clarify the statements, a video is made for the participants and is added to the survey. The survey consists of the following four steps:

1. Introduction video and overview of all the statements
2. Rank the statements: Agree, neutral, or disagree
3. Rank the statements: Q-grid (see Figure 1)
4. Comment on most extreme ranked statements (4 and -4)

Q-analysis

When all statements (Q-set) are filled out in the format (Q-sort) by the participants (P-set) the results can be analyzed in the Q-analysis. Factor analysis can reveal the participants' subjectivity whereafter they can be grouped. The number of factors to extract is determined by (a) quantitative objective rules (22-24), (b) qualitative guidelines, and (c) qualitative explained value. Per group the dominant perspectives can be distilled from the corresponding Q-sorts. Besides, the participants are asked to explain their choices for the most extreme options. This helps with understanding discourse in the different perspectives per group of participants.

RESULTS

The factor analysis shows that four different perspectives can be identified. To investigate the meaning of those factors, the quantitative information following from the factor analysis is translated to a qualitative perspective. The different outcomes listed below are assessed in order to construct the perspectives (24):

- Significantly distinguishing statements per factor;
- Extremely ranked statements per factor;
- Overall consensus-disagreement on statements and correlation between factors;
- Feedback on choices made by participants.

In the analysis, six different factor solutions were explored as can be seen in **Table 3**. Multiple solutions meet the objective rules regarding cumulative % explained variance (46% ≥35%), eigenvalues (≥1), and Q-sorts per factor (≥2). The qualitative guidelines (24) are used to assess the solution. Both factor solutions 5 and 6 do not meet the simplicity criteria. Finally, qualitative explained value is checked

to make the decision between the factor solutions 3 and 4. Contradictions in extremely ranked statements are found in the factor solution 3 which makes it subordinate to the factor solution 4. This means that now 4 different perspectives can be distinguished within the group of stakeholders.

TABLE 3 Factors with Corresponding Eigenvalues and Explained Variance (KADE v1.2.0)

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**	**Factor 6**
Eigenvalues	4.8487	3.0477	2.5822	2.4864	1.9321	1.8974
% explained variance	17	11	9	9	7	7
Cumulative % explained variance	17	28	37	46	53	60

All the different perspectives are related to a Q-sort for a certain group of respondents that showed correlations between their ranked formats. In this study, this resulted in 4 Q-sorts, and subsequently in 4 perspectives. The 4 different Q-sorts are elaborated upon together with the perspectives by showing a table of the statements and their corresponding Z-scores (which are their ranks). Showing the statements in one Q-sort could indicate that some statements are ranked more extreme than others in all cases, while this differs for each perspective

Perspective 1

Trust in an open platform and standardization of loading units to make urban freight logistics more sustainable, realistic regulation needed to set boundaries.

This perspective is positive about the standardization of loading units and open platform logistics. Such an open platform will have a positive effect on city livability, but there is a chance that it will create a monopoly. Municipalities should increase urban freight logistics regulations yet the goals should be achievable for the logistics sector. The actors behind this perspective are both municipalities and LSPs. It is interesting that most of those LSPs are parcel handlers which might have caused the positive attitude towards loading unit standardization (see Table 4).

TABLE 4 Z-scores on Factors Perspective 1

Statement	**Sig.**	**Factor 1**	Factor 2	Factor 3	Factor 4
* = P<0.05, **=P<0.01	-	**Z-score**	Z-score	Z-score	Z-score
Standardization of smaller-sized loading units will lead to higher load factors, especially in urban logistics.	**	**1.71**	-0.15	-0.39	0.59
The biggest inefficiencies in urban freight logistics are caused by shippers and receivers taking care of their own transport.	-	**1.62**	0.09	1.7	-0.36
Size standardization of smaller loading units will accelerate the sharing of assets.	**	**1.56**	0.1	0	0.15
An open platform where logistics service demand and supply meet will be the future of logistics.	-	**1.46**	0.16	0.5	1.67
Standardization of smaller loading units should be introduced by a governmental organization.	**	**1.41**	-0.87	-1.33	-1.57

Municipalities should obligate data sharing, just like the obligation to use zero-emission vehicles in the future.	**	**-1.09**	-2.31	0.97	1.57
Zero-emission zones are going to provide low emission logistics but will increase total vehicle kilometers.	**	**-1.51**	1.13	0.29	0.4
Urban freight logistics is already quite efficient and does not form a very urgent problem otherwise there would be more regulation already.	-	**-1.61**	-0.09	-1.47	-1.92
Although the margins are small the logistics sector is not being challenged enough to get more efficient.	**	**-1.74**	-0.33	0.77	-0.23
An open platform for assets sharing will improve efficiency but will ultimately result in a decrease of urban livability.	-	**-1.86**	-0.12	-0.75	-1.6

Perspective 2

It is already possible to work very efficiently, moderately negative towards PI characteristics, and governmental influence should be limited.

This perspective says that a lot is possible already when it comes to sustainable and efficient urban operations. It shows a relatively negative attitude towards regulation and does not think that client relationships can be sustained in open platform logistics. There is no unambiguous view on postponement of ZES regulations - the LSPs in this perspective seem to embrace this however the municipalities do not want them (**Table 5**).

TABLE 5 Z-scores on Factors Perspective 2

Statement	**Sig.**	Factor 1	**Factor 2**	Factor 3	Factor 4
* = P<0.05, **=P<0.01	-	Z-score	**Z-score**	Z-score	Z-score
The current level of data format standardization is generally sufficient for the sharing of assets.	**	-0.54	**1.72**	-1.54	0.07
Strong long-lasting client relationships cannot be sustained with a system based on asset sharing.	**	-1.06	**1.61**	-1.83	0.59
Most logistics companies are not digitally ready for data sharing while they should be.	-	-0.6	**1.3**	0.81	0.59
Sharing distribution centers on the outskirts of cities will remove the need for urban consolidation centers.	-	0.07	**1.18**	0.79	-0.69
The hidden costs in logistics make fair assignment of costs and benefits a major barrier for asset sharing concepts.	-	1.09	**1.17**	0.26	0.54
Most logistics service providers have the will to share assets but the transition costs currently do not outweigh the benefits.	**	-0.2	**-1.11**	0.22	-0.25
When data is shared on a large scale the bigger companies are mainly going to benefit from it.	-	-0.28	**-1.14**	-0.37	-0.54
A disruption in the logistics sector is needed to make companies share their data.	**	0.41	**-1.77**	0.52	0.46
A governmental organization should be in charge of a standardized data-sharing platform.	**	0.98	**-1.99**	-0.13	0.52
Municipalities should obligate data sharing, just like the obligation to use zero-emission vehicles in the future.	**	-1.09	**-2.31**	0.97	1.57

Perspective 3

Zero-emission is important but operations should primarily become more efficient, asset sharing and data standardization are promising to achieve this.

Great importance towards increasing efficiency characterizes this perspective. Greater efficiency will have more impact on city liveability rather than changing to ZE vehicles. Open platform logistics could provide a solution for the current unsustainability issues and therefore data format standardization is needed. An open platform will cause different relations with the clients but additional services can still be provided. Ultimately, innovation will have to come from the sector, but the government must set certain limits and encourage good initiatives. This perspective is mainly detected among municipalities but also exists at a logistics service provider (**Table 6**).

TABLE 6 Z-scores on Factors Perspective 3

Statement	Sig.	Factor 1	Factor 2	**Factor 3**	Factor 4
* = P<0.05, **=P<0.01		Z-score	Z-score	**Z-score**	Z-score
Increased efficiency by sharing assets increases city livability more than changing to zero-emission vehicles in urban freight logistics.	**	-0.19	0.67	**1.9**	0.72
The biggest inefficiencies in urban freight logistics are caused by shippers and receivers taking care of their own transport.	-	1.62	0.09	**1.7**	-0.36
Some say the fear of sharing competitive information is a big barrier to sharing data but in reality, this isn't the major problem.	-	0.32	0.97	**1.2**	-1.25
The reason why shippers and receivers provide their own transport is mainly that they do not see it as extra costs	*	0.31	0.3	**1.01**	-0.22
An open platform for asset sharing causes better competition instead of forming a monopoly.	-	0.03	-0.45	**1**	1.02
Postponing certain emission restrictions in urban areas from 2025 to 2030 is needed to keep urban freight logistics affordable.	-	0.06	1.11	**-1.35**	-0.75
Sharing assets in urban logistics are very complicated due to an abundance of client-specific services that are currently offered.	**	0.26	-0.28	**-1.39**	0.8
Urban freight logistics is already quite efficient and does not form a very urgent problem otherwise there would be more regulation already.	-	-1.61	-0.09	**-1.47**	-1.92
The current level of data format standardization is generally sufficient for the sharing of assets.	**	-0.54	1.72	**-1.54**	0.07
Strong long-lasting client relationships cannot be sustained with a system based on asset sharing.	**	-1.06	1.61	**-1.83**	0.59

Perspective 4

An open platform will bring more efficiency to urban freight logistics and city hubs will still be needed together with regulation and stimulation.

According to this perspective, more regulation around city logistics is well conceivable, for example with regard to the sharing of data. The latter will have to be coordinated nationally. However, regulating is not as easy; it is a big challenge for municipalities. An open platform where supply and demand can be matched is promising and could be the future of the logistics sector. It can be difficult to maintain the same relationships with the customers by using this new way of working, and the fear of sharing competitively sensitive information. In the future, the city hubs will also play an important role in ensuring sustainable and efficient city logistics. This perspective was found at governmental organizations and LSPs specializing in urban freight logistics (**Table 7**).

TABLE 7 Z-scores on Factors Perspective 4

Statement	**Sig.**	Factor 1	Factor 2	Factor 3	**Factor 4**
* = P<0.05, **=P<0.01		Z-score	Z-score	Z-score	**Z-score**
Municipalities should regulate urban freight logistics more to tackle unsustainable issues but it should be nationally coordinated.	-	1.24	-0.42	0.6	**1.68**
An open platform where logistics service demand and supply meet will be the future of logistics.	-	1.46	0.16	0.5	**1.67**
Municipalities should obligate data sharing, just like the obligation to use zero-emission vehicles in the future.	-	-1.09	-2.31	0.97	**1.57**
Pilots that are done to improve urban logistics are mostly executed with small volumes and have a small chance of succeeding.	-	-0.3	0.81	0.06	**1.2**
An open platform for asset sharing causes better competition instead of forming a monopoly.	-	0.03	-0.45	1	**1.02**
Standardization of smaller loading units should be introduced by a governmental organization.	-	1.41	-0.87	-1.33	**-1.57**
An open platform for assets sharing will improve efficiency but will ultimately result in a decrease in urban livability.	-	-1.86	-0.12	-0.75	**-1.6**
The introduction of zero-emission zones will exclude the smaller logistics service providers from the urban logistics market.	**	0.26	-0.82	-0.21	**-1.64**
Urban freight logistics is already quite efficient and does not form a very urgent problem otherwise there would be more regulation already.	-	-1.61	-0.09	-1.47	**-1.92**
An open platform where logistics service demand and supply meet will exclude a lot of logistics service providers from the logistics market.	*	-1.07	-0.16	-1.24	**-1.93**

The Similarities and Differences between the Perspectives

When looking at the differences between perspectives, it stands out that perspective 2 differs most from the others, especially for the most distinguishing and extreme ranked statements. The difference between perspective 2 and the other perspectives (1, 3 and 4) can also be seen in **Table 8** where the correlations between factors are depicted.

TABLE 8 Z-scores on Factors Perspective 4

	Factor 1	**Factor 2**	**Factor 3**	**Factor 4**
Factor 1	1	-0.1122	0.2381	0.2704
Factor 2	-0.1122	1	-0.0779	-0.0024
Factor 3	0.2381	-0.0779	1	0.3498
Factor 4	0.2704	-0.0024	0.3498	1

To depict what these differences and similarities look like, the distinguishing statements from factor 2 are assessed and related to factors 1, 3, and 4. These statements show that a lot can be done already in the current situation and that the situation might not be as bad as it is sometimes presented. According to factor 2, an open platform would not be satisfying, since this would not allow LSPs to maintain strong relations with their clients. Through 'normal' collaboration between parties already a lot can be achieved, thereby potentially making dedicated urban consolidation centers less important. Zero-emission zones might cause extra vehicle kilometers and postponing certain regulations related to this might not be a bad idea. Besides, municipalities should not heavily regulate urban freight. Yet, if they do, it should be coordinated nationally.

The perceptive above does not match the other perspectives in multiple ways. According to the latter, a zero-emission zone is necessary yet only as a part of the solution. Regulations around this should only be postponed when really necessary. PI characteristics are generally perceived as positive (see Figure 3). However, one perspective ascribes more importance to the standardization of loading units, while the other attaches more value to the standardization of data formats. It is generally thought in factors 1, 3, and 4 that an open system, where logistics supply and demand meets, is promising for the future of the sector.

In addition, it is interesting to see that regulation is not viewed negatively in any of the perspectives. Yet, there certainly are differences in the degree of regulation. For example, perspective 3 states that municipalities only need to set boundaries while perspective 1 argues that a government organization should introduce a standard for loading units (**Figure 2**). There is consensus that more regulation is welcome in urban freight logistics, however, it must be coordinated nationally.

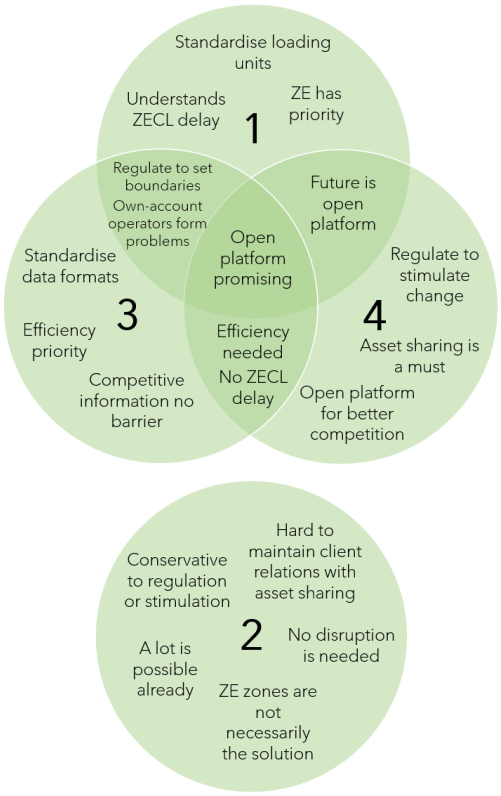

Figure 2 Similarities and Differences between all the Perspectives

IMPLEMENTATION

To make the step to implement the different perspectives are used to research what characteristics of PI are promising to make urban freight logistics more sustainable. Besides, the aim is also to reveal what barriers and opportunities there are in relation to those characteristics.

Barriers and Opportunities

As the results show, the majority (1, 3, and 4) of the perspectives has a generally positive attitude towards PI characteristics. An open network is found promising in all of these three perspectives and divided over those perspectives the other characteristics are ranked positively as well. The standardization of loading units and the standardization of data formats are mentioned as important only in perspectives 1 and 3 explicitly.

Perspective (2) does not show a positive attitude towards the implementation of PI characteristics. The LSPs representing that factor state that they already work in a very collaborative and efficient way. According to them a major change to a new system does not seem to be needed. However, their attitude towards the PI characteristics was not entirely negative as well. Besides, collaborations are a first step to a growing open supply network which is actually a part of the PI vision (20).

The knowledge that perspectives 1,3 and 4 are generally positive towards PI characteristics is helpful but it does not explain why there are no widespread 'PI-like-networks' already. In our research the following barriers have been identified from the textual explanations in the Q-survey:

- Open platform can introduce monopolies;
- LSPs are digitally not advanced enough;
- Fear of sharing competition sensitive information;

- Current networks suffice;
- Transition costs to a new system;
- Inability to maintain strong relations with asset sharing;
- Specific services cannot be provided with asset sharing;
- Allocation of cost and benefits with asset sharing.

This shows that multiple barriers are still in place in relation to the PI characteristics. For many of these barriers opportunities mentioned in the survey can be opposed. However, the barrier stating it is hard to allocate costs and benefits accordingly when sharing assets is not being opposed by an opportunity.

One more thing stands out regarding the transition costs to the new system. The opportunities related to this barrier say that a certain 'urgency' has to come to accelerate a disruption. At this moment there is no real need to make a change to a more efficient system. To deal with this there should be an 'environment where efficiency pays off' which gives the sector an incentive to get in action.

Creating an Environment Where Efficiency Pays Off

As currently there is no need to change, coincides well with the generally positive assessment of the statements related to increasing regulations regarding urban freight logistics, which has the potential to create a certain need to change. This can be achieved by drawing up unambiguous, national regulations setting clear boundaries for urban freight logistics per municipality. This contains regulations on certain subjects that can be adjusted per municipality according to their requirements. The subjects of these measures are determined in consultation with the logistics sector and the Ministry of Infrastructure and Water Management. Clear communication towards the logistics sector concerning the restrictions in that specific area is needed per municipality. In addition, municipalities also indicate that it is important for the logistics sector to share information with them, as with the provisioning of better insight into their operations more realistic goals can be set.

Not all perspectives have agreed on the influence of municipalities in other policy areas. That is why it is decided not to actively set up government initiatives, along the lines of perspective 2 which emphasizes that the market develops quite well on its own. However, it is interesting to help the sector by investigating the barriers they encounter. Research may contribute to creating mutual understanding and removing these barriers, thereby enabling the sector to innovate itself.

CONCLUSIONS AND DISCUSSION

The aim of this research is to find out what opportunities exist for PI characteristics and what barriers co-exist. Revealed perspectives from a group of municipalities, LSPs, and branch organizations show that there is a generally positive attitude towards PI-related developments. Three perspectives have a positive attitude towards the open system where logistics supply and demand meet. Besides, there is trust in standardizing loading units and data formats, however not so much widespread as the positive attitude towards the open system.

Only perspective 2 does not seem to be as interested in PI characteristics as the rest of the perspectives. According to this perspective, a lot can be established right now through collaboration and therefore there is no need for PI-like developments. However, the attitude towards the PI characteristics was not entirely negative as collaborations can be interpreted as a first step towards an open supply network as addressed in the PI vision (20).

Multiple barriers still exist regarding the implementation of PI characteristics. A fair allocation of costs and benefits in an open system seems to be a significant barrier. It is also remarkable that multiple participants stated that there currently is no real need to change. Most perspectives show a positive attitude towards regulation in urban freight logistics. This is mainly based on the attitudes towards zero-deliveries in the inner-cities and not based on the general perception to improve efficiency for the whole sector (instead of the individual company's perspective).

This positive view on regulations and the current absence of a need to change is paired in a framework. This framework consists of actions between different stakeholders in order to realize an 'environment where efficiency pays off'. Nationally coordinated regulations should be established and adjusted to each municipality, as this will bring clarity in the current 'jungle' of regulations. The boundaries set by the municipalities will create a need to change - working towards more efficient operations.

A critical reflection can be made on the application of the Q-methodology. Results can only be validated by feeding back the resulting perspectives to the participants and letting them assess those (20). This means that these perspectives are indeed present within the group, but cannot be generalized to a bigger population. Due to that condition, it cannot be ruled out that other perspectives exist on the subject. Q-methodology proves to be helpful in revealing different perspectives on the subject. However, the scope and the subject of the research is quite comprehensive. Also, the interpretation of the perspectives is quite challenging since multiple statements are in some cases merged into one statement. Yet, the validation has shown that perspectives seem to be quite accurate still and the insight in the perspectives provides a good opportunity to proceed with implementing PI in city logistics according to a well-defined roadmap.

AUTHOR CONTRIBUTIONS

The authors confirm contribution to the paper as follows: study conception and design: All authors; data collection: C.B.H. van Son; analysis and interpretation of results: All authors; draft manuscript preparation: J.H.R. van Duin, C.B.H. van Son. All authors reviewed the results and approved the final version of the manuscript.

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