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# The bumpy road to the adoption of the Physical Internet – Overcoming barriers from a stakeholder perspective

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***Abstract:*** *The Physical Internet aims for a paradigm shift by eliminating the unsustainability issues in today's supply chain processes. The development of the concept in recent years has shown that the PI is still in its conceptualization phase. In order to increase the attention and adoption of the concept both, in literature and practice, empirical knowledge is needed concerning how and why affected stakeholders will adopt the concept. To address this gap, we gathered qualitative data through a single embedded case study approach. In total, we have integrated 14 stakeholders with verifiable expertise in the PI. The sample consists of logistics and transport service providers, shippers and includes companies selling or working on specific PI-products. Furthermore, we gathered empirical data from research institutes with specific knowledge or projects in the PI. This paper provides insights about the adoption of the PI and in particular about stakeholder intentions, organizational and technological readiness as well as barriers and drivers.*

***Keywords:*** *Physical Internet, Case Study, Open networks, Drivers*

## 1 Introduction

Driven by increasing global freight transportations and demanding stakeholder requirements, organizations are forced to rethink current value chain configurations and to design the handling and usage of physical objects economically, environmentally and in a socially sustainable manner. Today's logistics are responsible for approximately 7% of global greenhouse gas emissions, caused by fossil fuels burned for road, rail, air and sea transport (Stern, 2008). More than 20% of these transportations are caused by trucks running empty, resulting in significant inefficiencies of costs and emissions, which make logistics highly unsustainable (European Commission, 2014).

The Physical Internet (PI) aims to address these sustainability issues by combining and aggregating single logistics networks into one global logistics network, which integrates physical assets, such as hubs or containers, and human or organizational actors (Montreuil, 2011). The PI can be understood as a concept that defines the way, how physical goods or objects are moved, handled and delivered from the source to the destination. The PI thereby differs from the way today`s logistics processes work in three key aspects. First, physical goods are transported in standardized and modular PI-containers instead of in individual packaging. Second, PI participating companies share and use all existing production facilities, hubs and distribution centers for the realization, storage, and transshipment of goods. In the PI, this refers to the openness of the PI-nodes. Third, the routing of the PI-containers from source to destination is executed by the PI-movers in an intermodal way from one PI-node to the next with multiple load transfers in between. Simulations have shown considerable benefits from these changes for individual companies and for the whole network in terms of supply chain visibility, security, agility and sustainability, while at the same time, cost

reductions through increased capacity utilization and high customer service levels (Montreuil et al., 2012a; Fazili et al., 2016; Sarraj et al., 2013).

The idea of the PI is based on the digital internet, which brought a reconceptualization to the worldwide information web through its transparent interconnectivity between networks and nodes in an open network structure (Montreuil, 2011). By transforming the way information is routed through the digital internet to the way physical objects are routed through the PI, a system is created that focuses on the interconnectivity of universal physical, operational, digital and business elements (Montreuil et al., 2010). In such networks, resources like transportation assets, hubs, and containers are shared along the supply chain (Sarraj et al., 2013).

Within the PI, intermodal transportation can be applied more efficiently. While current transportations mainly follow point-to-point transits, the PI enables to split the transport at the PI-nodes to re-decide on the most time efficient, economic efficient and environmentally efficient way to route the products (Lin et al., 2013; Montreuil et al., 2015). This decentralized route planning allows consolidating shipments at each hub (Pach et al., 2014). Today, shipper and logistics service provider plan transport routes, delivery time and supporting services like track and trace in advance and agree upon them by contract. In the PI, the planning process is outsourced to the PI network, which in turn is responsible for allocating PI-containers to the respective transport mode on short notice (Montreuil et al., 2013; Meller et al., 2013; Ballot et al., 2013; Walha et al., 2016).

The PI received high interest from researchers and practitioners alike during recent years (Sternberg and Norrman, 2017). Previous research focused on the description of a perfectly implemented concept and its positive effects, without emphasizing practical, theoretically and empirically grounded experiences of the PI (Pan et al., 2017; Sternberg and Norrman, 2017; Treiblmaier et al., 2016). It leaves fundamental questions regarding how and why companies should change their current processes towards the way the PI concepts describes them unanswered. For this paper, we define this transformation process as the adoption of the PI by participating stakeholders.

Considering the various stakeholders who are affected by the PI and the necessary changes regarding supply chain processes and structures, questions arise as to why companies drive for the implementation of the Physical Internet and how the integration of the concept in current business models will occur. Empirically grounded answers for these questions have so far not been investigated (Sternberg and Norrman, 2017). Due to the novel nature of the concept and its practical relevance, we use an exploratory single embedded case study approach to build knowledge on stakeholder intentions and changing supply chain processes and structures. This approach allows us to gain insights from different stakeholder groups, who are all vital for the development of the PI.

Following the adoption model, as it is used by Sternberg and Norrman (2017) for the PI, we focus our research on the perceived benefits as well as organizational readiness of relevant stakeholders in regard to the PI. The application of this model on relevant stakeholders serves as the basis for our study. Stakeholders which are directly influenced by the PI in their supply chain or business model can be classified into three groups, which are providers (carriers, storage facilities), enablers (freight forwarders, who often include carriers acting as integrators), and shippers (user, manufacturer) of logistics services (Crainic and Montreuil, 2015). Within this study, we combine enablers and providers of logistics services into LSPs, as they often integrate forwarding as well as carrier and warehousing services into one business. Furthermore, we distinguish between existing LSPs and companies that recently started to build up PI-products such as software or hardware solutions, which sometimes also have a second business within the provider or enabler environment. Since current efforts in

developing an implementation roadmap to further support the adoption process are primarily conducted by researchers, we also integrate researchers into our study.

As a result, we emphasize companies' perceived benefits as well as their organizational and technological readiness. In addition, we contribute by working out barriers relating to new supply chain management and leadership structures in the PI. We found that shippers will have the highest interest for the realization of the PI and that they will force logistics service providers to adapt their business models accordingly. On the other hand, we depict a change of mindset within the organizational readiness of companies combined with unsolved issues regarding network responsibilities and leadership as main barriers for adoption.

The remainder of the text is structured as followed. First, we present our single embedded case study methodology. Subsequently, we describe detailed findings from our analysis regarding drivers, organizational and technological readiness as well as barriers for the adoption of the PI. The paper ends with a concluding discussion, implications as well as limitations and a further research agenda.

# 2 CASE STUDY METHOD

The lack of a clear roadmap for the adoption of the Physical Internet requires a broad and deep investigation of stakeholder intentions. Current studies focus on conceptual frameworks without emphasizing economical and practical needs for affected stakeholders to accelerate or hinder the adoption of the PI. The shows a high degree of uncertainty that requires multilateral examination. In line with this purpose, we, therefore, opted for an exploratory embedded single case study approach, as the situation being evaluated has no clear, single set of outcomes. The case study method can provide insights into the early phases of research and practical backgrounds while maintaining a holistic view of the phenomenon (Yin, 2014; Eisenhardt, 1989). Moreover, in particular for upcoming topics that lack practical penetration and grounded theory, case study research allows one to integrate and react spontaneously to upcoming themes and to explore key variables and their relationships (Yin, 2014).

## 2.1 Study design

In our study, the PI is the investigated phenomenon in the context of the logistics industry. We, therefore, collected information from various industries and academics as embedded units of the PI case. Since our purpose is to contribute to the adoption of the PI, the case itself is the main area of interest. To avoid biases we grounded our research on a clear methodology based on Gibbert et al. (2008) and Yin (2014) in regard to construct validity, internal validity, external validity and reliability throughout our study design, case selection, data gathering, and data analysis. Based on the conceptual framework, we first interviewed key informants from various stakeholder groups and integrated further units in a second step until we felt that we had collected sufficient data in each stakeholder group and that additional interviews would not reveal further information. This approach enabled comprehensive insights while increasing construct and internal validity to reach theoretical saturation (Eisenhardt, 1989; Strauss and Corbin, 1998). In total, 14 interviews were conducted with academic experts from universities and research organizations and with industry experts from logistics service providers, PI-product firms, consumer good and automotive companies, and intralogistics firms. The semi-structured interviews lasted 45-90 minutes and were all conducted via online conferences between January and March 2018 by the same two researchers. Each interview was recorded and transcribed with consent before they were sent back to the interviewees to eliminate misunderstandings and give them the opportunity to further integrate thoughts (Yin, 2014). To further increase construct and internal validity, we analyzed multiple sources of evidence by triangulating interview data with secondary data from company presentations, company reports and trade publications to build up a case study database (Yin, 2014; Gibbert

et al., 2008). However, secondary data did not reveal additional information, but confirmed interview data. The presented results are therefore based on the interviews.

## 2.2 Case selection

Grounded on the exploratory nature of our study, we applied the diverse case method (Seawright and Gerring, 2008) by integrating a high variance of stakeholders to gather exhaustive data along the relevant dimensions of the PI, as guided by the previously developed framework. That firstly includes the logistics and transportation category as the industry most affected by the PI through infrastructure changes and horizontal collaboration (*Alpha*). The interviewed companies in this section are providers of transportation, in-house logistics, and forwarding solutions. Second is the shipper industry, where we interviewed manufacturers from retail and the automotive industry (*Beta*). Third, are companies that had already started to invest in the PI with self-developing or producing PI products or software (*Gamma*). And fourth are independent researchers and organizations who actively work on the PI in terms of concept, product or business model innovations (*Delta*). The four selected dimensions represent a broad range of categories characterizing individual PI stakeholders and specific relationships between those stakeholders (Seawright and Gerring, 2008). Within the categories, we opted for homogeneity and chose units that are typical of each category. However, given the prerequisites regarding existing firm sizes within the categories, the units differ across the categories. In categories *Alpha, Beta,* and *Delta,* we focused on large firms and institutions, as they are particularly appropriate when a phenomenon is new (Koufteros et al., 2007), especially as they are more likely to have the resources and capabilities to invest in this new concept. In contrast, in category *Gamma*, start-ups and small companies have, until now, dominated, making them the focus units for this category. Due to the fact that these companies are often specialized in one single PI product or software, theoretical saturation occurred after a higher amount of cases, compared to the other categories. In each company, we purposively interviewed individuals in senior management levels with background knowledge of the observed topic demonstrated by previous publications or interviews. To ensure anonymity of the interviewees and companies, we used Greek letters as company names. Table 2 gives an overview of the interviewed cases and their characteristics.

We interviewed experts from seven different countries from Europe and Canada. This data allowed us to create a holistic picture of the PI concept, identifying drivers for adoption, but also barriers that need to be overcome.

*Table 1: Overview of interviewed case units*

| Category | Unit | Industry | Company Size* | Country | Informants' job title | Integration of PI in processes | Member ALICE |
|---|---|---|---|---|---|---|---|
| **Logistics / Transport Service Provider (Alpha)** | **$A_{Alpha}$** | Forwarder / Carrier | Large | Germany | Business Consultant | Strategy; Pilot projects | No |
| | **$B_{Alpha}$** | Forwarder / Carrier | Large | Austria | Head of Innovation | Innovation | Yes |
| | **$C_{Alpha}$** | Intralogistics | Medium | Austria | Head of Product Mgmt. | Innovation; Pilot projects (urban hubs) | No |
| **Shipper (Beta)** | **$D_{Beta}$** | Automotive | Large | Germany | Managing Futurist | Strategy; Pilot projects (routing, transshipment) | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | $E_{Beta}$ | Consumer goods | Large | Belgium | Futurist and research fellow | Strategy; Pilot projects (intermodal transport, collaborative logistics arrangements) | Yes |
| **PI-product companies (Gamma)** | $F_{Gamma}$ | Transport and Logistics Consultant | Small | Norway | CEO | Freight consolidation and collaboration system/software | Yes |
| | $G_{Gamma}$ | Packaging | Medium | Belgium | Product Manager | Modular packaging; observations | Yes |
| | $H_{Gamma}$ | Trailer | Small | Canada | CEO | Trailer prototype | No |
| | $I_{Gamma}$ | Logistics Software | Small | Austria | Senior Consultant | Simulations | Yes |
| | $J_{Gamma}$ | Logistics Software | Small | France | CEO | Warehouse matching platform, information bundling | No |
| | $K_{Gamma}$ | Trailer | Small | Canada | CEO | Trailer prototype; Freight consolidation platform | No |
| **Researcher (Delta)** | $L_{Delta}$ | Logistics / research institute | N/A | Germany | Department Head | Research; Observations | Yes |
| | $M_{Delta}$ | Logistics / research institute | N/A | Germany | Strategic Researcher | Research; European pilot projects | Yes |
| | $N_{Delta}$ | Logistics / research institute | N/A | Norway | Strategic Researcher | Research; European pilot projects | No |

* Small companies: employees: 0-100, revenue: $0-$10 million
Medium companies: employees: 100-1000 revenue: $10 million - $1 billion
Large companies: employees: >1000, revenue: >$1 billion

# 3 ANALYSIS AND DISCUSSION

## 3.1 Description of interviewed units

All interviewees had previous knowledge or experience with the concept of the PI for over two years. Eight units are members of ALICE taking part in regular workshops or pilot projects. Six units had previously participated in one of the International Physical Internet Conferences. Although we addressed companies that are aware of the PI in particular, the study showed a broad awareness rising with key industry players, who already deal with the concept. All interviewees stated that the PI will affect global supply chain management processes during the next few years and they are confident that logistics will develop towards the PI. However, the level of adoption is still low, as research and pilot projects are the dominating level at which the companies integrate parts of the PI into their processes.

Within the interviewed logistics and transport service providers, the PI is mainly integrated into overarching departments, such as strategy or innovation, to search for business cases and possible application fields. Only one provider of intralogistics infrastructure and services started with a pilot project by building urban hubs to consolidate freight, before it is transported to customers in the city. The main activities of logistics and transport service providers focus on market observations, whereby special attention is paid to actions taken by shippers towards the PI, as company $B_{Alpha}$ stated:

> *We observe the whole topic of the PI, to determine what the shippers are doing in this direction […].*

They all report that the transport industry is highly cost driven and that the PI will only have a chance to be widely adopted if there is a positive cost-benefit relation. They state, that the claimed benefits of the concept need to be proven by pilot projects or simulations before broad adoption of the concept will take place within the logistics industry. The LSPs are convinced that logistics will develop towards the ideas connected to the PI but are careful with new concepts, especially when these concepts target their way of doing business. They, therefore, place themselves in a rather reactive position instead of leading the adoption process.

Interviews with shippers from two manufacturing industries showed that there are already pilot projects in place dealing with the routing and transshipment in the PI as well as with intermodal transport solutions and collaborative logistics arrangements. However, in both companies a deeper integration from the strategy department into operative processes has so far not been possible, as internal barriers hinder a faster adoption:

> *It is difficult to persuade the management of the Physical Internet idea, as by 2050, when ALICE expects a complete implementation of the concept, only a few of the current managers will still be in the company.*

Within the PI-product category, three companies ($H_{Gamma}$, $J_{Gamma,}$ and $K_{Gamma}$) solely work on products that are designed for the PI. The other three companies developed software or container solutions as a part of their daily business focus, such as consultants or software provider. These solutions deal with freight consolidation and cross-industry collaboration software ($F_{Gamma}$, $I_{Gamma}$) and modular packaging ($G_{Gamma}$). All PI-product companies had previous experiences in the logistics industry, where they identified several inefficiencies regarding capacity utilization in transport and warehousing. In order to eliminate the inefficiency, they either founded startups or implemented new products or software within their companies.

In the research category, we interviewed three logistics institutes. Two of these institutes work closely with ALICE in various pilot projects in order to test theoretical concepts in a practical environment. Their goal is to reach a consensus between industry partners and researchers. Therefore, all researchers state that it is essential to implement parts of the concept in real-world environments in order to analyze the effects and benefits of the PI on relevant stakeholders. To support this approach, we asked all interviewees about the perceived benefits which drive them to adopt the PI.

### 3.2 Drivers for the adoption of the Physical Internet

The adoption of the PI is highly dependent on the perceived benefits each stakeholder earns from an implementation of the concept into their own supply chain processes. We found that large logistics service providers are already aware of the concept, but act reactively to the implementation efforts of shippers rather than proactively opting for pilot projects or business case developments themselves. In contrast, all interviewees consider shippers to be drivers for the PI, as they can expect the biggest benefits from the concept. From the customer view,

shippers of products are responsible for fast and secure deliveries. Furthermore, it was stated that customers increasingly demand additional services, such as complete visibility of shipments through track and trace. In line with the claimed benefits of Montreuil et al. (2012a), Fazili et al. (2016) and Sarraj et al. (2013), our study confirms improved visibility, agility and security as well as lower costs and improved sustainability as advantages of PI processes, which would directly increase customer satisfaction. To meet increasing customer expectations, shippers continuously optimize and integrate additional services into their supply process. In order to do so, shippers have to forward customer wishes to the operators of logistics services. However, all interviewees of the category *Beta* declared that the adoption of such services by the operators entails long negotiations and new contracts while changing customer requirements are demanding a dynamic negotiation process. In contrast to this, the interviewees expect significant improvements through the PI, as its open structures allow shippers to have better access to different LSPs and their services. Subsequently, the interviewed shippers see the PI as a concept, which directly improves their supply chain processes, increases customer satisfaction and reduces efforts to access additional services from carriers and other providers of logistics services. Interviewee $N_{Delta}$ even states:

> *The clients of logistics service providers are playing an important role because they are forcing them to change. The shippers are actually forcing the forwarders to change.*

However, also LSPs and in particular PI product companies outline benefits for their processes in the form of higher efficiencies and reduced costs.

As outlined before, the initial aim by implementing the PI is to solve the unsustainability issues in logistics. However, while shippers pointed out that their customers demand an improvement of the ecological and social sustainability in the transportation process, none of the interviewees stated that these sustainability components would be a reason for them to adopt. All reported benefits relate to an improvement in cost or revenue efficiency. The PI, therefore, has to have an economical short-term benefit for the stakeholders in order to convince them to adopt. This economic benefit can result from increased customer satisfaction or new business models generating additional value.

All interviewees reported that the PI attacks the business model of logistics service providers as it works today. Within an open and shared network, LSPs fear to lose customers, networks, and infrastructure as a competitive advantage, as it would allow other providers of logistics services to use the given infrastructure. Moreover, the global consolidation of shipments in the PI combined with a central allocation of those shipments to carriers and warehouses would take over the transport and storage planning process of LSPs, leaving only the physical handling of the products to generate revenues. However, the interviewees also pointed out that the physical transport is more efficient in the PI, as empty running is reduced and resources are better utilized, which can be confirmed by the PI-product companies, whose solutions are already in use. Through convertible trailers company $H_{Gamma}$ was able to reduce empty miles in their fleet from 40% to less than 5%. Moreover, $F_{Gamma}$ invented a platform, which intelligently consolidates freight and reduces herewith the number of trucks along the main run of the transport. Through this process, they were able to increase the load factor of different LSPs from 45% to 90%.

Nevertheless, especially transport service providers (*Alpha*) point out that, in the future, transportation and product handling will not be the main source of income anymore. Instead, additional services will become increasingly important. In this context, the interviewees predict that, in the PI, the fight for customers will not be decided by the price, but rather by the services a company offers. The newly gained visibility allows companies to gather extensive data on the transportation process, which companies can use to offer additional services to their customers. The interviewed providers of logistics services unanimously see

herein new business models that need to be adopted. One logistics service provider states that considering the PI as an attack on their business is too close-minded, as possible potentials are often unseen. They feel certain that the way revenues are generated today will change and that they need to adapt their business model respectively. For instance, they see new services in the analysis of loading data for trucks. The optimization of this data leads to more efficient packing of products within different transport modes. Moreover, the analysis of transport data combined with technological developments within the fields of big data and predictive analytics facilitates new service offerings for supply chain risk management. Thereby, hazards and disruptions in the network are anticipated at an early stage to allow for the reorganization of material flows in advance.

Based on the various new services, the interviewees expect a distributed value creation in the PI with infrastructure providers, providers of physical tasks, such as for transportation and handling of products, and special service providers to enable visibility to use the generated data. All interviewees predict a transformation of their business model, rather than an elimination. However, even though the logistics service providers outline benefits by offering additional services, they so far only react to developments without actively testing or implementing new business models. The possible perceived benefits, which global LSPs can gain from a transformation of their physical business models to digital business models, currently stand in contrast to the fear of losing their competitive advantage in the form of their customers, their infrastructure and particularly their global transportation and warehouse network.

As most of the interviewees point out, it is important to distinguish between different LSP companies. While big providers of transportation services fear to open up their international networks, small LSPs can benefit from a shared infrastructure. These LSPs are often limited to local network structures, which is why shippers often prefer big LSPs in the allocation of shipments. An open network would allow small LSPs to reach distant customers, increasing their volume of transportations and making competition with big LSPs possible. Moreover, our study shows that LSPs profit the most from higher capacity utilization of their trucks, as small internal volumes often not allow for consolidating freight efficiently. The growing number of small LSPs in organizations like ALICE and as participants of the product provided by the PI product companies confirms the high motivation of these companies to be part of a shared and open network. Accordingly, most interviewees see them as the pioneers for horizontal collaboration and the adoption of the concept.

The adoption constraints of big LSPs and the benefits that drive small LSPs to implement a shared network indicates that the implementation of the PI will follow a hybrid concept, rather than a global and complete implementation within a short time. Only one interviewee expects an implementation of everyone at the same time. The perceived benefits accelerate the adoption of horizontal collaboration and the development of shared networks between small LSPs, leading to a partial implementation of the PI. The developed network works as a new business model in itself, competing with the closed networks and business models of global LSPs. Within this business model innovation, additional value is created for customers through increased visibility and sustainability as well as lower costs.

### 3.3 Organizational and technological readiness

While perceived benefits motivate organizations to change their way of doing business, companies also have to be ready in terms of organizational and technological readiness to adopt an innovation. All interviewees stated that there are several barriers in the logistics industry hindering the adoption process. They reported that changes within their companies take time due to traditionally grown habits. The transformation of their businesses to the PI requires a broad cultural change, which reportedly scares employees as well as the

management within the logistics companies. Most of these companies are still not involved in innovations to change the way they are doing business, as the CEO of company $K_{Gamma}$ states:

> *It is tough to change a traditional industry in which people are used to 100-year-old habits, where everybody runs around doing the same old thing because that is what worked yesterday, instead of looking in the future to come up with better ways of to do things.*

A change of mindset to overcome traditionally grown habits in terms of collaborating with other companies is therefore needed as a first step to adopt the PI. The interviewed shippers and PI product companies in particular rate the change of mindset as the biggest barrier, which needs to be overcome before the adoption of the concept can occur.

In addition to organizational readiness, technological readiness is required for the adoption of an innovation. We asked all interviewees about technologies that are needed for the implementation of the PI in their business environment. All interviewees agree that new innovations are not required from a technological perspective. Information technologies, algorithms and warehouse technologies for the transshipment of containers are already in place. However, the interviewees also stated that the adoption penetration of these technologies has to expand throughout the industry. Several companies still need to adopt technological innovations in order to allow communication between production, warehouses and transport facilities. In this context, the interviewees rate the expansion of sensor technologies (RFID) in combination with the Internet of Things (IoT) as the most important enabling technology. Another technology which is seen as a fundamental component in the literature to make the PI possible are globally standardized and modular combinable containers. These containers were contentiously discussed in the interviews. While shippers rate the containers as a necessity to enable the secure handling and protection of their products, providers of logistics services and researchers think that standardized containers would make the implementation of the PI unnecessarily complicated. They argue that the containers themselves are not required to bundle shipments and to enable fast transshipment in hubs. Moreover, broad adoption and harmonization of the containers are costly and time intensive. Improvements in automated loading and transshipment of variable packages or even single products allow the adoption of the PI idea without the help of standardized containers. Accordingly, standardized containers would be advantageous to reveal the full potential of the concept, however, the majority of interviewees agreed that the PI can be successfully implemented without a global standardization of containers.

### 3.4 Barriers and changing supply chain processes

In today's supply chain processes, LSPs have a direct relationship with shippers, to whom they are offering their services. The PI changes this relationship between shipper and LSP, as the PI network coordinates the allocation of shipments and additional services to the provider of those services. LSPs and shippers, therefore, lose their direct relationship, which alters the way services are offered and the way value is created. The configuration of creating value for customers shifts from a direct value creation based on a contractual agreement to a distributed value creation within a network. This circumstance raises questions about the configuration of this value network, which includes the management of the PI, the way services are offered and rewarded as well as the contractual, liability and ownership conditions. To gain insights into the effects of a distributed value creation network on the logistics industry, we asked the interviewees to what extent their supply chain management processes change within the PI. This way, we were also able to analyze risks that occur along the adoption process, mainly within the management of the PI network.

LSPs, in particular, anticipate broad changes within their processes, as they expect to lose the planning process of transportation routes and shipment allocation to the PI network. Shippers

and LSPs both describe the planning process of transportations as very time intensive, due to long negotiations regarding transport routes, prices, and additional services. The PI, on the other hand, requires fast and dynamic planning of transport routes as well as container or product allocation to the respective transport mode. Only this way, the PI can assure the efficient utilization of capacities within trucks, aiming for a reduction of the total amount of trucks on the road and increased sustainability. Transportations are therefore no longer planned on the basis of a contractual agreement, but rather are dependent on the efficiency that can be achieved through an optimal allocation of shipments. The process changes from static planning, where shippers book a fixed set of services from end to end, to dynamic planning, in which the PI network spontaneously decides the process. On the one hand, this requires trusted algorithms that plan the transport process within a short time after the shipments arrive in the hubs, as interviewee $L_{Delta}$ states:

> *[…] the customer has to have confidence in the algorithms, that the products reach their destination within the expected time. The problem is that customers always have to worry that their shipments do not get the regard and priority which they expect or need.*

On the other hand, shippers no longer know who is handling or transporting their products. Therefore, shippers fear to lose a contact person who can be held responsible in case of disruptions and delays within the transport process or in case of product damages during handling. The interviewees are concerned about giving up control over their shipments and losing the ability to interfere in the transport process, as service providers change frequently. They describe the PI as a black box, even though they have complete visibility over their processes.

The PI will be responsible for allocating shipments to the service providers, which fundamentally alters the supplier-customer relationship as it works today. LSPs no longer offer their services directly to their customers (shippers). Instead, the value network changes, as all providers of logistics services, such as carriers or warehouse providers, offer their services to the PI or the manager of the network. Providers of logistics services will therefore only have a contractual relationship with the PI, which in turn decides who will be part of the network. Almost all interviewees state that there will eventually be one instance responsible for managing the PI. Currently, there is almost no literature on this topic and hardly any project or company has been dealing with the question of power and leadership within the PI. This uncertainty unsettles the interviewed companies, especially the LSPs, as they fear giving up all the power to one organization. Out of 11 interviewees who talk about the leadership conditions within the PI, only $F_{Gamma}$ and $K_{Gamma}$ imagine that the leadership will be in control of a public or non-profit organization. All other interviewees are certain that one stakeholder or company will excel and manage the PI. The interviewees agree that the management of the PI will be in the form of a platform, similar to already existing digital freight matching platforms, which bring together shippers of products and carriers with free capacities. In the PI, one platform would be responsible for the allocation of shipments and could therefore directly influence which provider conducts which transport. The provider of the platform could become very powerful, leading to monopolistic conditions, as interviewee $C_{Alpha}$ states:

> *If the thought of the PI becomes reality […], it has to be decided if people want one company managing the PI. One big company as the leader would create a huge monopoly. Smaller carriers would not have a chance anymore if they do not serve the platform.*

The interviewees agree that a company with the ability to manage and develop such a platform will become the leader. Five interviewees independently name Amazon as a potential manager of the network. According to the interviewees, Amazon is currently not

satisfied with their logistical contractors, conditions, and performance. Thus, they work and invest in logistical assets themselves. Combined with the IT knowledge from their main business (platforms) Amazon currently has the highest chance to take up that role, as $F_{Gamma}$ states:

> *If Amazon continues to grow without any competition, then they end up being the network.*

Other interviewees argue that one of the big freight forwarders will eventually manage the network and explains that there are already companies who drive for this position. Those companies have a strong motivation for the fast adoption of the PI. However, as long as governance models of the PI stay uncertain, companies fear that the concept would become monopolistic, which stands in clear contrast to a shared and open concept based on horizontal collaboration, as it is presented in the PI. Therefore, a solution has to be found which fairly and trustfully allocates shipments and services to the respective providers. Only in this way could stakeholders be motivated to further drive for the adoption of the PI. Most interviewees see standard protocols that clearly define how shipments are allocated and how new providers can join the network as part of the solution to prevent the PI from becoming monopolistic. However, bundling of processes still requires a database or platform where incoming shipments are consolidated, processed and further routed.

Another barrier emerging from the changing value network in the PI deals with the rewarding of logistics services in such a network. So far, there is no clear description as to how different service providers are rewarded for their services. While interviewees confirm standard protocols as a prerequisite for solving this problem, they also state that there has to be a technological solution managing this process. Since service providers do not have a contract with shippers, the PI as a network needs to reward their services.

The unknown responsibility and leadership conditions within the PI network are rated as key barriers by all interviewees for the adoption of the PI. Moreover, next to the presented possibilities for stakeholders to create value through a change of their business models within the value network of the PI, a solution is needed to prevent monopolistic structures. The interviewees expect this to be changed through additional business models in combination with standard protocols. Four interviewees also see upcoming distributed ledger technologies, such as Blockchain, as a technological solution for several barriers within the PI. They anticipate that Blockchain could enable trustful and secure data sharing between competing companies. Moreover, as Blockchain technology makes middlemen in certain processes unnecessary, the interviewees predict potentials for the decentralized allocation of transportations, which could eliminate the single leadership by a centralized platform.

In an innovation adoption context, questions about responsibilities and leadership need to be answered in order to drive stakeholders to further adopt the concept. In this regard, it is necessary to define stakeholder roles and establish business models or technological solutions dealing with trustful and fair conduction of processes.

# 4 CONTRIBUTION, IMPLICATIONS AND FURTHER RESEARCH

Based on an embedded single case study, we investigated the adoption process of the PI by relevant stakeholders from an innovation adoption perspective. We interviewed experts from logistics service providers, shippers, PI product companies and researchers to gain insights into the perceived benefits of stakeholder groups adopting the PI as well as current organizational readiness to implement the concept. Since current efforts in investigating the PI phenomenon are lacking in terms of empirically grounded research, our findings are valuable for both scholars and practitioners.

In the analysis of our case study, we outline several drivers regarding perceived benefits and new business models, which currently motivate relevant stakeholders to adopt the PI. On the other hand, we reveal fundamental barriers within the organizational readiness as well as concerning responsibility and leadership conditions.

From a managerial perspective, our study shows that adopting the PI is valuable for shippers, small logistics service providers, and PI product companies, as higher visibility and open network structures result in improved flexibility, higher capacity utilization and lower costs. Shippers can, therefore, better meet customer expectations while increasing the ability to easily access additional services from various service providers. Moreover, an open network allows smaller logistics service provider to reach customers globally while allowing the possibility of competing with the closed networks of large LSPs. Additionally, the identified change of mindset is a requirement for the adoption and therefore essential for stakeholders to pursue. Finally, large LSPs have to decide whether they transform their current business model in order to get involved in the adoption process and building herein new ways of creating value, or if they cut themselves off from the PI, risking the competition of an open network within a hybrid structure. These findings provide guidance for practitioners adopting the PI and reveal information about underlying conditions and prerequisites for open and shared networks.

However, as with every other empirical research, our study has some limitations. Although case study research is especially suited to provide insights into the early phases of research and practical backgrounds, while maintaining a holistic view on the phenomenon (Yin, 2014; Eisenhardt 1989), this approach is limited in terms of generalization. Therefore, although we chose the interviewees based on a systematic process, it is not possible to conclude that the findings are generalizable for all companies. It would be interesting to investigate small logistics service providers in particular to confirm some of the developed propositions and to gain deeper insights into their specific way of adoption.

Our study also reveals further research topics that can guide scholars for future investigations. First, the outlined barriers, in the form of responsibility and liability conditions need to be solved in order to expedite the adoption process. As stated by the interviewees, standard protocols and business model innovations are needed to define stakeholder roles and to deal with this issue. Second, it is advisable to clarify leadership conditions to prevent monopolistic structures. It will be interesting to see if distributed ledger technologies could help to enable horizontal collaboration through a trustful exchange of information.

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