# The Acceptance of Sustainable Freight Transport

# 5

## 5.1 Theoretical Background on Behavioral Intention and Technology Acceptance

In this subchapter, multiple theoretical perspectives are considered which are suitable to explain why logistics service providers are willing to implement sustainable freight transport strategies in theory. The conceptual framework illustrated in this subchapter provides the theoretical foundation for the second research question (Which determinants influence the acceptance of sustainable freight transport strategies?). The primary theory which informs the second research question is the technology acceptance Model (TAM) published by Davis (1989). TAM belongs to the group of so-called behavioral theories (Yuen *et al.*, 2017) which try to explain individuals' behavioral intention. In the following, the most prominent and widely used behavioral theories will be explained in detail.

### 5.1.1 Theory of Reasoned Action

Researchers aimed to estimate the acceptance of innovations and new technologies for decades. A very early and fundamental model which contributes to understanding the concept of acceptance is the "theory of reasoned action" (TRA), published by Fishbein and Ajzen (1975). TRA is considered to be one of the most influential models in the social and psychological literature (Staats, 2004). TRA aims to predict a person's intention to behave in a certain way. Fishbein and Ajzen postulate that behavioral intention will ultimately lead to behavior. According to TRA, there are two determinants which influence behavioral intention, namely the *attitude towards the behavior* on the one hand, and *subjective*



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*norm* on the other hand (Figure 5.1). The attitude represents an individual's tendency to assess the specific behavior as positive or negative (Ajzen and Fishbein, 1980). In the case of companies, attitude is often reflected in the companies' management philosophy (Yuen *et al.*, 2017). The management philosophy can promote or hamper sustainable business practices such as sustainable transport strategies. Subjective norm can be described as social influence or pressure which supports or impedes a particular behavior (Schepers and Wetzels, 2007). In the business context, subjective norms may be caused by shareholders or stakeholders who approve or disapprove specific business practices (Yuen *et al.*, 2017).

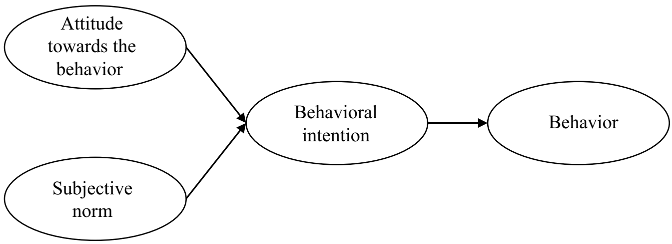


**Figure 5.1** Theory of reasoned action. (Fishbein and Ajzen, 1975)

### 5.1.2 Theory of Planned Behavior

An important assumption of TRA is that individuals act upon volitional control, which means that they suppose to be able to perform the behavior whenever they are willing to do so (Madden *et al.*, 1992). However, behavioral control is often a variable determinant, as it is depending on the individual capabilities and opportunities of the person or company in charge (Staats, 2004). To address this aspect, Ajzen refined TRA and developed the theory of planned behavior (TPB; Ajzen, 1985; Ajzen, 1991). Compared to TRA, TPB additionally involves the construct *perceived behavioral control* (Figure 5.2). Perceived behavioral control describes the degree to which individuals believe they are able to accomplish a task or execute a behavior due to their

competences or external circumstances (Staats, 2004). Most often, sustainable strategies are also dependent on competences or external circumstances, e.g. knowledge or existing facilities. For example, LNG can only be used if there are refueling stations available, and realizing a modal shift requires knowledge about the organization of multimodal transport services. TPB therefore improves the understanding of why and how sustainable strategies are implemented.

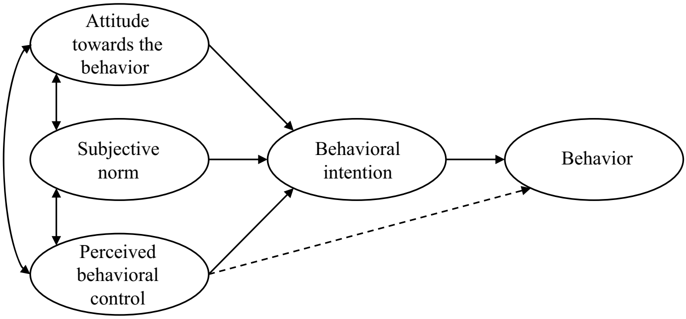


**Figure 5.2** Theory of planned behavior. (Ajzen, 1991)

### 5.1.3 Technology Acceptance Model

One of the most influential and most widely used extensions of the theory of reasoned action (Fishbein and Ajzen, 1975) and the theory of planned behavior (Ajzen, 1991) is the technology acceptance model (Davis, 1989). According to Fishbein and Ajzens' work there is close coherence between attitude and behavior: Figure 5.1 and Figure 5.2 illustrate that behavioral intention, such as the intention to use a technology, is determined by a person's attitude. Davis (1989) specifies the construct "attitude toward using a technology" by introducing two external variables. These new variables are *perceived usefulness* and *perceived ease of use* (Figure 5.3). Perceived usefulness denotes the degree to which it is believed that using a particular system is advantageous to enhance the overall performance (Davis, 1989). Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Davis claims that all else being equal, a technology is more likely to be accepted by users if its application is considered to be useful and easy to use.

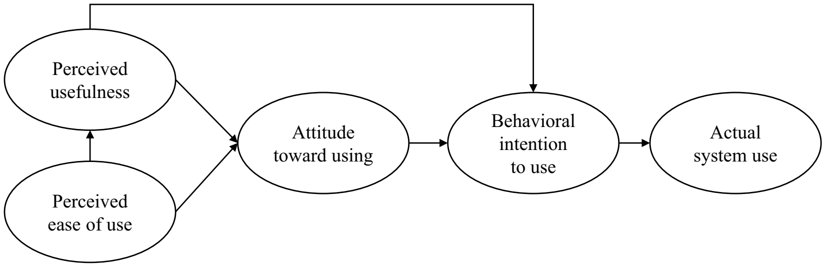


**Figure 5.3** Technology acceptance model. (Davis, 1989)

Davis' technology acceptance model (TAM) originally focused on assessing the acceptance of information technology. By now TAM has already been employed on various other technologies from different research fields, as diverse as health care (Holden and Karsh, 2010), energy technologies (Chen *et al.*, 2017), pedagogy (Alharbi and Drew, 2014), nutritional science (Ronteltap *et al.*, 2008), and many more. A main advantage of TAM is that it is very simple and easy to use, yet a powerful model to explain users' technology acceptance (Lee *et al.*, 2003). TAM has been frequently applied in the context of transport and logistics. Manifold studies exist using TAM in context of sustainable transport strategies (Table 5.1). As can be seen in Table 5.1, TAM is suitable to explain the acceptance of avoid, shift as well as improve strategies for sustainable transport. Many studies refer to passenger transport, but TAM is also used to model the acceptance of innovations and technologies in freight transport. As a matter of fact, the majority of studies listed in Table 5.1 regard "improve strategies", which constitute technological innovations to achieve sustainability (see Chapter 4). For example, there are studies about alternative fuels acceptance (e.g. Hackbarth and Madlener, 2013; van Rijnsoever *et al.*, 2013) or truck platooning (Castritius *et al.*, 2020). The technology acceptance model is especially suitable to explain improve strategies, since TAM was originally designed to study technology acceptance. However, other studies also use TAM to assess the acceptance of avoid strategies (e.g. reducing transport by pooling rides or car-sharing; Wang *et al.*, 2018 and Geldmacher *et al.*, 2017) and shift strategies (e.g. modal shift towards public transport or bicycles; Chen and Chao, 2011 and Hazen *et al.*, 2015).

**Table 5.1** List of studies using TAM in context of sustainable transport strategies

| ASI pillar | Sustainable transport strategy | Reference | Determinants of acceptance (additional to the determinants proposed by Davis (1989)) |
|---|---|---|---|
| avoid | Ride-sharing services | Wang *et al.* (2018) | Personal innovativeness, perceived risk, environmental awareness |
| | Car-sharing | Fleury *et al.* (2017) | Perceived environmental friendliness, effort expectancy, performance expectancy, facilitating conditions |
| | | Geldmacher *et al.* (2017) | Social influence, effort expectancy, performance expectancy, facilitating conditions |
| shift | Public transport | Chen and Chao (2011) | Habit, perceived behavior control, subjective norm |
| | Public bicycle systems | Hazen *et al.* (2015) | Perceived convenience, perceived quality, perceived value |
| improve | Alternative fuel vehicles | Hackbarth and Madlener (2013) | Purchase price, fuel cost, $CO_2$ emissions, driving range, fuel availability, refueling time, battery recharging time, policy incentives |
| | | van Rijnsoever *et al.* (2013) | Initial purchase price, fuel price, driving range, time to refuel, availability of fuel, local emissions |
| | Electric vehicles | Wang *et al.* (2016) | Environmental concern, attitude toward adopting a hybrid electric vehicle (HEV), subjective norm, perceived behavioral control, personal moral norm, intention to adopt a HEV |

(continued)

**Table 5.1** (continued)

| ASI pillar | Sustainable transport strategy | Reference | Determinants of acceptance (additional to the determinants proposed by Davis (1989)) |
|---|---|---|---|
| | | Sang and Bekhet (2015) | Government intervention, environmental concern, performance attributes, social influence, financial benefits, demographic, infrastructure readiness |
| | | Zhang *et al.* (2011) | Demographic variables, understanding of alternative fuel vehicles, experience, vehicle performance, government policy, environmental requirement, opinion of peers, vehicle price, tax reduction, fuel price, fuel availability, maintenance cost, vehicle safety |
| | Hydrogen vehicles | Huijts *et al.* (2014) | Intention to act, attitude towards acting, perceived effects of the technology, subjective norm, perceived behavioural control, personal norm, outcome efficacy, environmental problem perception, energy security problem perception, problem perception, trust in the municipality, trust in the industry, distributive fairness, positive affect, negative affect |
| | | Tarigan *et al.* (2012) | Demographic variables, knowledge, environmental attitude, willingness to pay more to purchase hydrogen vehicles |

(continued)

**Table 5.1** (continued)

| ASI pillar | Sustainable transport strategy | Reference | Determinants of acceptance (additional to the determinants proposed by Davis (1989)) |
|---|---|---|---|
| | | Kang and Park (2011) | Psychological needs, perception towards hydrogen fuel cell vehicles, values, experience |
| | | Thesen and Langhelle (2008) | Demographic variables, hydrogen support, environmental and hydrogen knowledge, attitude |
| | | Zachariah-Wolff and Hemmes, 2006 | Demographic variables, knowledge, perception, attitude |
| | | O'Garra *et al.* (2005) | Demographic variables, environmental attitude, environmental knowledge, environmental behavior knowledge about hydrogen and fuel cells, attitude toward science and technology |
| | | Schulte *et al.* (2004) | Perception of product, values of person in question, wants of person in question, needs of person in question, past experience, social background |
| | Natural gas vehicles | Pfoser *et al.* (2018d) | Accessibility/availability of technology and refueling stations, attitude towards alternative fuels and interest in LNG, safety concerns |
| | | Jayaraman *et al.* (2015) | Refueling station availability, payback period, petrol price, refueling time |
| | Truck platooning | Castritius *et al.* (2020) | Image, driving safety, technology affinity, trust in automated systems |

## 5.2 Determinants of Sustainable Freight Transport Acceptance

In the following subchapter, the determinants of sustainable freight transport acceptance will be elaborated. The technology acceptance model postulates that acceptance is determined by two main factors, namely usefulness and ease of use, which lead to a specific attitude about a system or technology. The aim of the following subchapter is to gain further insights on how usefulness and ease of use are formed in the context of sustainable transport strategies.

### 5.2.1 Overview / Comparison of Determinants

In Plasch *et al.* (2021), Pfoser (in press), Pfoser *et al.* (2016a) and Pfoser *et al.* (2018d) the factors which motivate (or hinder) logistics companies to implement sustainable freight transport strategies were elaborated. Each paper refers to one of the three ASI pillars: Plasch *et al.* (2021) describe the motives to enter a PI network, Pfoser (in press) analyzes the barriers to use multimodal freight transport, and Pfoser *et al.* (2018d) as well as Pfoser *et al.* (2016a) raise the determinants of LNG acceptance. In the following, the findings from the three papers will be juxtaposed to see what are the overarching determinants that influence the acceptance of sustainable freight transport strategies in general. Table 5.2 gives a comparison of the higher-level determinants which occur in context of PI, multimodality as well as LNG. There are some determinants which specify the usefulness of sustainable freight transport strategies, while other determinants specify the ease of using sustainable freight transport strategies (Figure 5.4). The following subchapters will describe the determinants in detail.

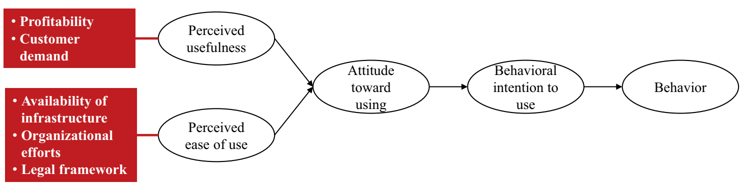


**Figure 5.4** Technology acceptance model specified for sustainable freight transport strategies

**Table 5.2** Determinants of sustainable freight transport acceptance

| **Determinant of sustainable freight transport acceptance** | **Avoid: Determinant in context of PI collaboration (cf. Plasch *et al.*, 2021)** | | **Shift: Determinant in context of multimodality (cf. Pfoser, in press)** | | **Improve: Determinant in context of LNG (cf. Pfoser *et al.*, 2016a and Pfoser *et al.*, 2018d)** | |
|---|---|---|---|---|---|---|
| **Profitability (~usefulness)** | + + | Cost reduction | + + | Investment costs, shipment characteristics | + + | Investment costs |
| **Customer demand (~usefulness)** | | | + + | Request from customers | + + | Request from customers |
| **Availability of infrastructure (~ease of use)** | + | No physical infrastructure but neutral IT platform | + + | Multimodal terminals, railway sidings | + + | Refueling stations |
| **Organizational efforts (~ease of use)** | + | Efficient orchestration and sharing mechanisms | + + | Administrative effort, pre- and post-haulage | + | Route planning |
| **Legal framework (~ease of use)** | + + | Data sharing policies, antitrust law | + + | Licensing processes, railway regulations | + + | Licensing processes |

+ + … *high relevance,* + … *medium relevance*

## 5.2.2 Profitability

The determinant which is clearly the most important factor influencing the acceptance of sustainable freight transport strategies is profitability. Profitability influences the perceived usefulness of sustainable freight transport strategies. Hardly any LSPs would introduce sustainable transport practices without expecting a cost reduction, or at least cost neutrality as compared to their “business as usual” strategy. This finding holds for all three types of sustainable strategies under analysis in this thesis; avoid, shift and improve.

In the case of technological innovations such as LNG trucks, it is important for LSPs that the purchase cost of the assets amortize during the expected useful life (Pfoser *et al.*, 2016a). LSPs face significantly higher investment costs when building up an LNG fleet since LNG trucks cost around one third more than diesel trucks (Scania, 2020). To evaluate the profitability of their investment, LSPs usually consider the total cost of ownership (TCO) and not only the initial purchase price of an asset (Pfoser *et al.*, 2016a). The increased investment for LNG trucks can therefore be offset by low operational costs (e.g. lower fuel prices compared to diesel).

To implement multimodal freight transport there might also be some investments required, for example to acquire multimodal (craneable) loading units. The main focus of the profitability considerations in the context of multimodal transport is however not on investment costs but rather on shipment characteristics (Pfoser, in press). As a matter of fact, multimodality is not suitable for every type of shipment. Transport distances and cargo volumes influence the economic viability of multimodal operations. The efficiency of multimodal freight transport is rather limited on short distances, for low cargo volumes and for time-sensitive cargo (Guglielminetti *et al.*, 2017). LSPs and shippers therefore evaluate carefully before setting up multimodal routes. The importance of economic viability towards a modal shift is also reflected in a myriad of mode choice studies. Meixell and Norbis (2008), Flodén *et al.* (2017) and Pfoser *et al.* (2018c) conducted literature reviews to compare the results of mode choice studies and all of them found that cost is usually the most important determinant that occurs in every study on mode choice.

Entering horizontal collaboration in a PI network is usually not bound up with the purchase of new assets and investment costs, instead it is more of a strategic decision. However, also in this case profitability is the most important driving force that influences the decision to participate in a PI network (Plasch *et al.*, 2021). The commitment to horizontal collaboration is bound up with some sacrifices, for example sharing data, resources or customer orders with competing organizations (Pan *et al.*, 2019). In return for making these sacrifices, logistics companies expect to gain economic advantages such as cost savings or increased turnover. All case companies in Plasch *et al.* (2021) stressed that the reduction of logistics costs is of very high priority to them. Achieving these cost reductions by bundling capacities in a PI network is a strong incentive for them to collaborate.

It should be noted that environmental benefits are a “nice to have” but not a decisive determinant for LSPs to introduce sustainable practices (Pfoser *et al.*, 2016a). Most LSPs acknowledge that emission savings and other environmental benefits are well suited for marketing purposes (“green washing”, McKinnon *et al.* (2015)), but what really matters for them is profitability. This came up very clearly in the context of all three sustainable freight transport strategies under study in this thesis. For example, during the in-depth interviews on multimodality, the respondent of LSP#4 affirmed:

*"I am working for quite some time in the transport sector and the topic of green logistics has been discussed for about ten years now… but I can tell you that we never, ever, had a customer who was willing to pay one Euro more for the transport service just to reduce $CO_2$ emissions!"*

This shows the limited importance that is put on environmental issues when deciding on a transport service, which is again confirmed by a vast number of mode choice studies (e.g. Flodén *et al.* (2017); Arencibia *et al.* (2015); Guilbault and Cruz (2010)). As stated by Flodén *et al.* (2017), the environmental impact in the selection process of a transport solution only accounts for 5% and is therefore only of minor importance for the acceptance of sustainable freight transport strategies.

### 5.2.3 Customer Demand

Implementing sustainable freight transport strategies can also be useful to meet the expectations and demand from customers and clients. For two types of sustainable transport strategy (multimodality and LNG) it turned out that requests from their customers constitute a main incentive for LSPs to introduce sustainable practices. In turn, if customers have a bad perception of sustainable freight transport strategies, LSPs will be reluctant to introduce these strategies (Pfoser, in press).

Pfoser *et al.* (2016a) found that an explicit customer request to use alternative fuels can be a main driver for LSPs to introduce LNG. Pfoser (in press) stated that customers' perception significantly influences the use of multimodal services. The reason is that it is the customer of the LSP (i.e. the shipper or cargo owner) who ultimately decides whether sustainable transport strategies are an option or not. If customers reject sustainable practices, then LSPs do not have an incentive to introduce these sustainable practices. This is also reflected in other studies which conclude that customer pressure strongly influence the green offerings of LSPs (e.g. Lin and Ho, 2011; Isaksson and Huge-Brodin, 2013; Chu *et al.*, 2019). Only for the PI it has not been found that a specific customer request supports the participation in a PI network. However, the general request for sustainable transport operations might encourage logistics companies to enter a PI network.

The empirical evidence collected within this thesis showed up where the case companies intended to implement sustainable transport strategies upon customer request. For example, a large manufacturer of commercial vehicles reported during the LNG focus group that a Dutch partner wanted them to construct an LNG refueling station at their company site in Austria. However, it turned out that the Dutch partner did not have enough transport volumes to fully utilize the refueling station. The internal plans to construct the refueling station were abandoned subsequently after the Dutch partner of the manufacturer withdrew their request. This example reveals that in the case of the manufacturer, the external request was the most decisive reason to implement LNG, and without this request the plans to implement LNG were abandoned. The same applies for multimodality. Out of ten LSPs which were asked about their intentions to use multimodal freight transport during the in-depth interviews, eight stated that this decision (at least partly) depends on their customers. For example, the respondent of LSP#10 stated:

*"We completely adapt to the customer requirements. If the customer demands multimodal transport, we organize multimodal transport. In most cases, the customer defines a specific delivery date or specifies the price that he is willing to pay. Then we have to check whether multimodal transport meets these customer requirements."*

### 5.2.4 Availability of Infrastructure

The availability of infrastructure is another determinant which influences the acceptance of all three sustainable freight transport strategies under evaluation in this thesis. A relevant difference between the three strategies is that for multimodality and LNG it is predominantly physical infrastructure that is needed, whereas for the PI no (additional) physical infrastructure is needed but rather a digital platform.

Infrastructure readiness plays an important role to promote market penetration and the acceptance of alternative fuels such as LNG. Refueling stations constitute the critical infrastructure which is necessary to introduce alternative fuels within LSPs' truck fleets (Pfoser *et al.*, 2018d). Arteconi and Polonara (2013) found that the use of LNG vehicles is directly related to the distance between the refueling infrastructure. At the moment, the density of the LNG refueling network is not very high, but it is continuously growing (Feldpausch-Jaegers *et al.*, 2016), which is beneficial for the acceptance of LNG.

In the case of multimodal freight transport, infrastructure such as multimodal terminals or railway sidings is required to operate multimodal services. This infrastructure often constitutes a crucial bottleneck hampering the uptake of multimodal transport due to low capacities and restricted opening hours (European Commission, 2011). Multimodal terminals are major nodes where all transport modes run together, thus they have an important role to facilitate a modal shift. If there is no infrastructure and equipment available to enable sufficient transshipment between the transport modes, the acceptance of multimodality is at risk (Pfoser, in press). Not only is physical infrastructure such as terminals crucial for the implementation of multimodal transport, but also digital infrastructure such as Information and communication technology (ICT) or intelligent transport systems (ITS). Various types of contextual information are required for an efficient organization of multimodal transports, e.g. data on weather, location of cargo, traffic information or potentially disturbances (Singh and van Sinderen, 2015). It is the task of ICT to provide high quality and standardized data that support multimodal transport decisions.

As mentioned above, the infrastructural requirements for establishing a PI network involve the set-up of a platform which acts as a neutral orchestrator. This neutral orchestrator can be described as a nonpartisan trustee, not involved in the operational activities, whose responsibility is to *"maximize the total synergy gains of the network while keeping its impartiality"* (Ciprés and de la Cruz, M. Teresa, 2019, p. 211). Essentially, without the neutral platform the performance of the PI network would be inferior and the acceptance of entering the PI network would be deterred.

Lacking the required infrastructure means that the ease of using sustainable freight transport is substantially reduced for LSPs. The provision of infrastructure for sustainable transport is often accompanied by a chicken-and-egg problem. This means that the supply of the relevant infrastructure (e.g. refueling stations, multimodal terminals or PI platform) is hampered by the fact that the demand for sustainable freight transport is quite low. At the same time, demand for sustainable freight transport is restrained because the relevant infrastructure is missing.

### 5.2.5 Organizational Efforts

Organizational efforts also influence how well a company accepts a sustainable freight transport strategy. If a sustainable practice is bound up with high organizational complexity, it decreases the ease of using this practice, and therefore the acceptance will be limited.

Especially multimodal transport is bound up with increased organizational effort compared to the less sustainable option unimodal road transport (Pfoser, in press). The reason is that sustainable transport modes such as railways or inland waterways have a lower network density, which means that it is difficult to establish point-to-point connections using these modes. Therefore, pre-haulage and/or post-haulage have to be organized in the course of multimodal transport. Another organizational burden are administrative barriers, which occur especially in transnational multimodal transport (Pfoser *et al.*, 2018b). Customs procedures, inspection processes and other formalities are time consuming and inhibit the acceptance of multimodality (Pfoser, in press). LSP#7 (in-depth interview on multimodality) named some further organizational efforts that might occur:

*„Compared to truck transport, multimodal transport is more complex because an increased number of players are involved and there are more interfaces to other organizations (e.g. railway companies) that you cannot influence.*

Organizational efforts may also arise from horizontal collaboration in a PI network due to the transactions with partners (e.g. asset sharing, exchange of transport requests, etc.) (Plasch *et al.*, 2021). Although it is the task of the network orchestrator to minimize the organizational efforts for the partners collaborating, there may remain some organizational issues (for example setting up the initial collaboration agreement).

In connection to LNG there might be some organizational efforts resulting from the low network density of refueling stations and the driving range (which is still somewhat shorter than that of diesel trucks). Due to these circumstances, route planning might be more complex for LNG fueled trucks (Pfoser *et al.*, 2016a).

### 5.2.6 Legal Framework

The legal framework is another determinant which influences the acceptance of sustainable freight transport. Logistics companies expect clear regulatory guidelines which support the introduction of sustainable strategies and which create legal security. In general, harmonization among the EU member states is desirable to ensure consistent regulations for transnational transport operations. This applies, for example, to the approval procedures required to authorize LNG vehicles and infrastructure (Pfoser *et al.*, 2016a) or to the issuing of safety certificates for multimodal railway undertakings (Pfoser, in press). At the moment, the licensing processes are often long-winded and discourage the use of sustainable freight transport strategies. In the focus group on LNG it was stated by a liquid gas provider that the legal framework conditions constitute the main barrier for the uptake of LNG in Austria. Also in the focus group on multimodality it was discussed that legislation is a crucial determinant of multimodal transport acceptance. A complex legal framework basically impedes infrastructure investments, for example for refueling stations or multimodal terminals (Reis *et al.*, 2013).

Another legal issue that has a large impact on multimodal road-rail transport is the state regulation of railways. Unlike the US, where rail infrastructure is mostly privately owned, rail infrastructure in Europe is a publicly owned monopoly which hampers competition. This is problematic because competition is decisive in enhancing the performance of the railway system and ensuring efficiency in terms of costs, quality of service and investment plans (Smith *et al.*, 2018; Mortimer and Islam, 2014; Clausen and Voll, 2013). To address this problem, the European Commission already adopted four legislative railway packages which target the liberalization of the European railway market (Smith *et al.*, 2018). However, Austrian LSPs only noticed a few improvements towards the liberalization and are not very satisfied with the railway providers (Pfoser, in press).

In the case of a PI network, specific legal issues emerge from the horizontal collaboration between partners, for example from the obligation to share data within the PI network. Logistics companies may have distinct data policies, i.e. terms and conditions that restrict data sharing and open data. Cooperation agreements should be drafted among these logistics companies to contract peer-to-peer connections (Hofman *et al.*, 2016). Knol *et al.* (2014) describe different scenarios for data sharing among transport actors. They recommend restricted open access and non-obligatory data sharing patterns to encourage information exchange in global transport chains. Horizontal collaboration in the PI network may not only be hampered because stakeholders are reluctant to work together, but they may simply not even be allowed to work together due to antitrust policies and regulations (Geerlings *et al.*, 2017). Here, governments have to intervene and create legal security for shippers and LSPs to enable horizontal collaboration.