LiSeGMo –
Linking Services for mobility of goods

Jürgen Zajicek – AIT Austrian Institute of Technology GmbH

Andreas Pell – FH OÖ Forschungs & Entwicklungs GmbH – Logistikum Steyr

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Partner

Authors

AIT Austrian Institute of Technology GmbH
Bernhard Heilmann
Karin Markvica
Jürgen Zajicek

FH OÖ Forschungs & Entwicklungs GmbH –
Logistikum Steyr
Andreas Pell

Board members

Sarah Bittner-Krautsack
bmvit

Stefan Mayr
Verkehrsauskunft Österreich VAO GmbH & ARGE ÖVV
OG

Martin Böhm
AustriaTech – Gesellschaft des Bundes für
technologiepolitische Maßnahmen GmbH

Svenja Hermann
FFG

Content

0. Executive Summary

The procedures for handling mobility and transport processes are based on organizational and technical structures that have evolved over time. Companies and participating organizations have developed tools to support the efficient handling of mobility requirements. These existing services are usually tailored to the needs of the participants or were developed by themselves and are usually isolated and proprietary solutions. The term "linking services" defines a concept that provides for the introduction of standardized interfaces (OpenAPIs) and new services whose task is the linking of individual solutions or of individual services offered on the market, e.g., for transport planning, transport processing, scheduling, freight exchanges, B2B and B2C services, etc. The concept could simplify the handling of transport processes and increase efficiency in the transport sector by avoiding sub-optimal operations. Furthermore, this will create the basis for the digitalization of transport processing and the establishment of the innovative concept of the "Physical Internet".

The aim of the study "Linking services for mobility of goods" is to survey the current framework conditions in the mobility of goods for the introduction of the "linking services" concept and, building on this, to clarify the following questions:

- What are the barriers to access data and information in the transport industry and logistics?
- Which potentials are recognized by the "linking" of different services in the field of mobility of goods?
- Which non-regulatory incentives could improve access to data and information in the transport industry and logistics?
- Under what circumstances are data holders and service providers in the field of mobility of goods prepared to make their inputs, such as data, information or their own services, available to third parties? Could this create access for new user groups?
- What could concrete business models in the cooperative use of data and information look like? Are there examples from other industries where this has already been successfully implemented?

Methods:

A three-part methodology was chosen for the structured processing of the questions. On the basis of the networks of the project partners and Desktop Research, the framework conditions were determined. Based on these results, a questionnaire was prepared, and in-depth expert interviews were conducted with relevant stakeholders in the following areas:

- Logistics Full Service Provider (DB Schenker, Gebrüder Weiss)
- Rail freight companies (RCA/RCG – Rail Cargo Group Austria AG, WLC – Wiener Lokalbahnen Cargo)
- Infrastructure manager (viadonau)
- Transportation Tendering Platform (Satiamo)
- Terminal operators (ÖBB Terminal Services Austria, CT Enns/CT Salzburg)
- Operator (Roland Spedition)

The findings from the expert interviews and the workshop were summarized in a third step and distributed to many stakeholders for evaluation in the form of an online questionnaire in German and English. Since the response rate was very low, the results were not included in the evaluation.

In addition to these activities, possible use cases for the use of linking services in freight traffic were discussed with experts from a railway operator. The railway operators provided valuable insights and feedback to define further use cases.

Findings from the expert interviews:

The findings are based on the results of existing studies as well as on the identified opinions from the expert interviews and the evaluation of the questionnaires.

One of the biggest **barriers** to access data and information as well as external services in the transport industry and logistics is the complexity of data protection and data sovereignty. Concerns arise that by providing internal information and granting access to internal services to outsiders, information on the usually very individual business relationships (networks) can be disclosed to the competition.

Furthermore, the loss of the **Unique-Selling-Proposition (USP)** and industrial espionage are feared. In addition, the different IT maturity of the companies involved can lead to problems, for example, because important information cannot be kept up to date. This could be caused by unstable Internet access, resulting in poor data quality and incompatibilities in the interoperability of linking services. To ensure the standardized connection to future linking services and IT security (data sovereignty), appropriate software tools (OpenAPI) must be purchased, operated and maintained, which are associated with considerable costs. This would put smaller companies at a disadvantage. Furthermore, the implementation of digitalization of transport services, which are usually very individually designed and difficult to standardize, represents a considerable barrier. The question of neutral monitoring and regulation of future linking services has also not been clarified. This is of importance since the deliberate setting of high access barriers does not guarantee non-discriminatory access for all interested subscribers. In addition, there are very different international practices and interpretations of antitrust law, competition law and the General Data Protection Regulation (GDPR). Their harmonization is a very complex process.

The **potential** offered by the "linking" of services in the area of mobility of goods is primarily considered to be the simplification of processes and better planning in advance through standardization (reduction of complexities through "digitalization of the forwarding model") and the opening of additional information channels (primarily shippers) in the area of procurement and distribution (primarily freight forwarders). This is connected with a higher transparency of supply chains and a better comparability of prices (reduction of production costs). Linking services enable regulatory intervention via routing service (e.g. Brenner route only for railway mode, etc.) or through dynamic pricing, whereby order peaks can be smoothed (e.g., terminal handling) and a better integration of production and transport can be achieved. The greatest **potential** through the introduction of linking services can be expected above all in small and medium-sized enterprises (SME) in the forwarding sector (which do not have their own software system and have less IT maturity). Here a step-by-step introduction makes sense for simple standard transports (without manual interaction, no dangerous goods, no deadline accuracy, etc.), first unimodal, followed by terminal and then pre-/post-carriage, serving as a pioneer for future application to more complex transports.

As a possible **non-regulative incentive** to improve access to data, information and existing services in the transport industry and logistics, serving as a basis for future linking services, the expected economic benefit of offering the services of the participants on a broad international level was identified. Together with the expected cost reduction through increased efficiency, based on a standardized exchange of information and services, synergy effects can be used to reduce production costs. Linking services can also be used as an additional information and sales channel. Thanks to standardized, structured and constantly available data, optimization algorithms can continuously react to current events. Sub-optima of the purely internal consideration can be avoided, and real overall optima can be achieved by including all data of business partners and traffic information data.

To increase the **willingness to provide data and information** to third parties as well as the use of internal services by third parties in the future, important framework conditions still need to be created or clarified. At the very least, basic information such as offered routes, timetables, standard prices, handling costs, etc. of the participating companies should be offered to create a basis of trust. Above all, a legal clarification of the binding nature of the offer and availability of the linking services and globally valid, verifiable framework agreements on liability issues, insurance, licenses and concessions must be created.

When the experts were asked about their attitudes, it was found that many potential users of linking services have hardly any points of contact with the term. Many people generally associate the term with the linking of data and information on the state of infrastructure and transport processes. A future implementation of linking services would have to use the same standards / protocols worldwide using standardized interfaces in the form of APIs (OpenAPI initiative) in order to offer the linking of decentralized services and offers. This would create a globally active "virtual" freight forwarder (system-of-systems) that would take over all process steps from the initiation of the order to the arrangement of the actual transport service to the invoicing of the services (actual transport, use of linking services, etc.).

The link can increase the quality of the data and the services involved and enable seamless information transfer, making the most up-to-date data and information always accessible through standardized data protocols. The necessary digitization of the relevant business processes in the companies is already taking place at large companies in the transport and production sector and is seen as an opportunity to counteract the enormous cost pressures. With linking services, monomodal solutions are combined to multimodal solutions, enabling better response in the event of disruptions and timely switching between transport modes. With the two identified approaches to the possible business models ("light" version via website and "professional" version via OpenAPI and blockchain technology) for the design of linking services, the existing resentments against the passing on of information and data to third parties and the use of own services by third parties could be eliminated, thus counteracting the previous sparse use of freight exchange platforms.

In addition, it was found that linking services for transport planning and allocation will only conditionally dissolve existing sales channels (e.g. by announcing loading space capacities, standard relations, etc.). Existing niches in the transport sector could hardly be supported via linking services with tailor-made solutions for certain companies or products. For small companies, however, this would result in an expansion of their sales channels, as they would be able to offer at least their simpler, standardized services on platforms that can be used worldwide without great effort (elimination of language barriers, etc.) via linking services. This raises the question of the future role of freight forwarding companies, as the introduction of linking services will in future mean that expertise in the planning and execution of simple transports will be stored in digital form and that it will be easier to compare offers using algorithms.

When the respondents were asked for their opinion, it was found that they believe that there is a risk of monopolies forming. Since linking services are seen as a tightrope walk in antitrust and competition law, it is possible that individual industry giants can exert a strong influence on emerging linking services and at the same time prevent the emergence of other independent services, e.g. through their market power. Compared to large enterprises, small companies usually use very rudimentary IT equipment for economic reasons. Many large shippers are also reluctant to provide data via interfaces. To participate in linking services, it is necessary to be equipped with standardized interfaces, which some transport companies (EME) cannot afford. For this purpose, it must also be clarified which organizational form can be chosen for the operation of linking services and how these organizations can be checked regarding to their business performance (fairness, etc.). The framework conditions must be chosen in such a way that no communities can form that exclude groups of companies due to possible access hurdles such as excessive user fees, excessively complex technical prerequisites, etc. The different IT maturity of the companies must not constitute an access barrier.

The architecture of platforms for linking services must focus on data protection so that no conclusions can be drawn about the business conduct of the users. To counter these critical points, well planned information campaigns regarding the essential functions of linking services must accompany their planning and implementation.

Concepts and business models:

Based on the findings from the expert interviews, two possible technical and organizational implementation concepts were examined using an exemplary multimodal transport chain. These are coordinated in such a way that they build on each other in chronological order.

The concept of several linking service platforms called **"light"** aims for an IT service provider upstream of the participating companies, which in particular enables less IT mature companies to participate in the world of linking services without major changes and investments in their own existing IT service landscape, albeit with a partly limited range of functions, time lag in the data and additional costs. This would enable all companies involved in the transport chain to participate in some form in linking services. This "proxy service" is also designed for the use via a web browser or a mobile app but can also be made available to its customers via proprietary bidirectional interfaces. An extended multimodal routing service could be connected to these via the standard OpenAPI. The price display and the invoicing of the use of this linking service platform is carried out via one-off initial costs, a current basic fee and an invoicing via the number of accesses ("Pay per Click"). This service interacts and thus supports the entire transport port process from planning and execution to payment and any claims for damages. In its simplest form, it includes the comparison of guide prices (tariffs), emissions, schedules and transit times of the offered routes. It is also possible to enter current data from transport and transshipment companies or forwarders. It also links services provided by transport infrastructure operators and other services in the field of intelligent transport systems (ITS).

With the "light" approach, smaller companies could also be quickly integrated into the linking services system landscape, even if they do not use their own services. These companies can purchase cost-effective APIs that offer basic functions for integration into linking services. These cost-effective APIs with basic functions (data management, order processing, uniform communication form, structured data records, etc.) should be provided by a merger of the large system providers. This can ensure that even small companies have easy access to this future technology.

The **"professional"** concept is the technical successor of the **"light"** concept and participating companies use their own standardized API (Application Programming Interface) according to the OpenAPI initiative to exchange information (order data, routing information, etc.) via REST protocols (Representational State Transfer). Users (transport companies, planning platforms, etc.) are free to choose whether they use their own OpenAPI interfaces based on their services (individual software) or API solutions from software providers. The OpenAPI interfaces offer standardized protocols for data exchange enabling linking existing services with various technical architectures and data formats (transport data, freight documents, tracking/tracing information, etc.). The API is responsible for retrieving company data and transport-relevant information from the company's own systems, translating them into the uniform protocols (e.g. REST, as

provided for in the OpenAPI initiative) and regulating bidirectional access rights. This will enable the cost-saving provision of uniform data that can be used worldwide, whereby existing services and solutions can still be used.

The implementation of linking services targets the automation of future handling & transport processes. Blockchain technology can be used as a tool within linking services to ensure the implementation and adoption of services. This means that linking services can also be used by participants who do not trust each other, since the processing of the necessary transactions is difficult to manipulate and remains permanently documented. In this concept, the billing of service usage is implemented via blockchain technologies. These technologies use tokens, which represent the equivalent of the quality and importance of the data or services provided for the processing of transport processes. Owners of tokens would pay proportionately less, if they frequently provided high-quality data that is of particular importance for the processing of linking services.

Recommendations for action:

For the implementation of a Linking Service Platform, especially using Blockchain technology, there is still a great need for research. Large system providers are already offering the first tools for the use of blockchain technology in certain industries, such as insurance, banking, energy and for individual applications in the mobility sector. However, cost-effective solutions need to be created to remove the identified barriers to entry for small businesses.

Due to the high investment requirement for the digitization of companies, the implementation of linking services can only take place via suitable internationally agreed support measures. This process must be accompanied by a structured and internationally coordinated information and opinion-forming process.

To carry out this process in a coordinated manner, an association with a worldwide scope is recommended. The task of the association should concentrate on the following points:

- Clear definition of the standards to be used
- Coordination and use of synergies with existing standardization organizations from the transport sector (GS1 for freight transport (container numbers, barcode, QR code) or TISA for passenger transport)
- Promoting cost-effective software packages for smaller companies that are jointly developed by large software providers and offer basic functions for handling transports and connecting to linking services via the standardized OpenAPI interfaces.
- Development of strategies for monitoring of future linking services in the areas of compliance with the legal framework, non-discriminatory access for all interested parties, correct economic processing of transactions, etc.

To simplify the integration of software in future linking services, recommendations should be developed for the architectures of future software products (services for special applications within and outside the transport sector). The software architecture should support a system-oriented organization of the exchange of information and access to internal services and already provide corresponding interfaces (OpenAPIs) or their subsequent implementation.

Executive Summary (German)

Die Abläufe zur Abwicklung von Mobilitäts- und Transportvorgängen („Gütermobilität") basieren auf historisch gewachsenen organisatorischen und technischen Strukturen. Dabei haben Unternehmen und beteiligte Organisationen Hilfsmittel zur Unterstützung einer effizienten Abwicklung des Mobilitätsbedarfes entwickelt. Diese existierenden Services sind meist auf die Bedürfnisse der Beteiligten maßgeschneidert bzw. wurden von diesen selbst entwickelt und stellen in der Regel Insellösungen dar. Der Begriff „Linking Services" definiert ein Konzept, das die Einführung von standardisierten Schnittstellen (OpenAPIs) und von neuen Services vorsieht, deren Aufgabe die Verknüpfung (Verlinkung) von einzelnen Lösungen bzw. von am Markt angebotenen einzelnen Services z.B. für Transportplanung, Transportabwicklung, Disposition, Frachtenbörsen, B2B und B2C-Services, etc. ist. Damit könnte eine Grundlage für die Integration von Insellösungen in Bezug auf die Abwicklung von Transporten geschaffen und die Effizienz im Transportsektor durch die Nutzung von damit geschaffenen Synergien gesteigert werden. Weiters wird so die Grundlage für vernetzte Logistiksysteme geschaffen und die Etablierung des innovativen Konzeptes des „Physical Internet" unterstützt.

Die Studie „Linking Services der Gütermobilität" hat zum Ziel, die aktuellen Rahmenbedingungen in der Gütermobilität für die Einführung des Konzepts „Linking Services" zu erheben. Darauf aufbauend sollen folgende Fragestellungen zu klären:

- Welche Barrieren gibt es beim Zugang zu Daten und Informationen in der Transportwirtschaft und Logistik?
- Welche Potenziale werden durch das „Verlinken" von verschiedenen Diensten/Services im Bereich der Gütermobilität erkannt?
- Welche nicht-regulativen Incentives könnten den Zugang zu Daten und Informationen in der Transportwirtschaft und Logistik verbessern?
- Unter welchen Rahmenbedingungen sind Datenhalter und Dienstanbieter in der Gütermobilität bereit ihre Inputs, wie Daten, Informationen oder eigene Services, Dritten zur Verfügung zu stellen? Könnte damit ein Zugang für neue Nutzergruppen geschaffen werden?
- Wie könnten konkrete Business-Modelle in der kooperativen Daten- und Informationsnutzung aussehen? Gibt es dazu Beispiele aus anderen Branchen, wo dies bereits erfolgreich umgesetzt wird?

Methodik:

Zur strukturierten Abarbeitung der Fragenstellungen wurde eine dreiteilige Methodik gewählt. Auf Basis der Netzwerke der Projektpartner und von Desktop Research wurden die Rahmenbedingungen erhoben. Auf Basis dieser Ergebnisse wurden ein Fragebogen erstellt und vertiefende ExpertInneninterviews mit relevanten StakeholderInnen folgender Bereiche geführt:

- Logistics Full Service Provider (DB Schenker, Gebrüder Weiss)
- Eisenbahngüterverkehrsunternehmen (RCA/RCG – Rail Cargo Group Austria AG, WLC – Wiener Lokalbahnen Cargo)
- Infrastrukturbetreiber (viadonau)
- Transportvergabeplattform (Satiamo)
- Terminalbetreiber (ÖBB Terminal Services Austria, Container Terminal Enns/Container Terminal Salzburg)
- Operator (Roland Spedition)

Die Erkenntnisse aus den ExpertInneninterviews wurden in einem dritten Schritt zusammengefasst und in Form eines Online-Fragebogens in deutscher und englischer Sprache an eine große Zahl an StakeholderInnen zur Evaluierung verteilt. Da die Rücklaufquote sehr gering ausfiel, wurde auf eine Einarbeitung der Ergebnisse schließlich verzichtet.

Neben diesen Aktivitäten wurden mögliche Anwendungsfälle für die Nutzung von Linking Services im Güterverkehr mit Experten eines Bahnbetreibers diskutiert. Die Bahnbetreiber lieferten wertvolle Erkenntnisse und Rückmeldungen, um weitere Anwendungsfälle zu definieren.

Erkenntnisse aus den Experteninterviews:

Die Erkenntnisse stützen sich sowohl auf Ergebnisse existierender Studien, als auch auf die identifizierten Meinungen aus den ExpertInneninterviews und der Auswertung der wenigen beantworteten Fragebögen.

Eine der größten **Barrieren** beim Zugang zu Daten und Informationen sowie zu externen Services stellt in der Transportwirtschaft und Logistik die Komplexität des Datenschutzes und der Datenhoheit dar. Dabei treten Bedenken auf, dass durch die Bereitstellung von internen Informationen sowie der Gewährung des Zugriffes auf interne Services für Außenstehende Informationen zu den meist sehr individuellen Geschäftsbeziehungen (Netzwerken) der Konkurrenz gegenüber offengelegt werden können. Weiters werden der Verlust der Unique-Selling-Proposition (USP) und Betriebsspionage befürchtet. Darüber hinaus kann die unterschiedliche IT-Reife der beteiligten Unternehmen zu Problemen führen, etwa indem wichtige Informationen nicht aktuell gehalten werden können. Dies könnte durch instabile Internetzugänge (kein Datenaustausch), schlechte Datenqualität oder Inkompatibilitäten bei der Interoperabilität der Linking Services bedingt sein. Für die Sicherstellung der standardisierten Anbindung an künftige Linking Services und der IT-Security und zur Sicherstellung der Datenhoheit sind entsprechende Softwaretools zu entwickeln, anzuschaffen, zu betreiben und zu warten, die mit erheblichen Kosten verbunden sind. Dabei würden kleinere Unternehmen benachteiligt werden. Weiters stellt die Umsetzung einer Digitalisierung der meist sehr individuell gestalteten und schwer zu standardisierenden Transportdienstleistungen eine erhebliche Barriere dar. Ungeklärt ist auch die Frage der neutralen Überwachung und Regulierung der künftigen Linking Services, um die Entstehung von Monopolen zu verhindern. Dies ist von besonderer Wichtigkeit, da durch das absichtliche Ansetzen von hohen Zugangsbarrieren ein diskriminierungsfreier Zugang für alle interessierten Teilnehmer/innen nicht gewährleistet ist. Außerdem besteht international eine sehr unterschiedliche Handhabung und Auslegung von Kartellrecht, Wettbewerbsrecht und der Datenschutz-Grundverordnung (DSGVO). Deren Harmonisierung stellt einen sehr komplexen Prozess dar.

Als **Potenziale** durch das „Verlinken" von Services im Bereich der Gütermobilität gelten vor allem die Vereinfachung der Prozesse und bessere Planung im Vorfeld durch Standardisierung (Reduktion der Komplexitäten durch „Digitalisierung des Speditionsmodelles") und die Öffnung von zusätzlichen Informationskanälen (vorrangig Verlader) im Bereich der Beschaffung und des Vertriebs (vorrangig Spediteur). Damit ist eine höhere Transparenz der Supply Chains und eine bessere Vergleichbarkeit der Preise (Senkung der Produktionskosten) verbunden. Linking Services ermöglichen ein regulatives Eingreifen via Routingservice (z.B. Brennerroute nur für Modus Bahn freigeben, etc.) oder durch dynamisches Pricing, wodurch Auftragsspitzen geglättet (z.B. Terminalumschlag) und eine bessere Verzahnung von Produktion und den Transporten erzielt werden können. Die größten **Potentiale** durch die Einführung von Linking Services sind vor allem bei kleinen und mittleren Betrieben im Speditionsbereich (ohne eigene Softwaresysteme und weniger IT-Reife) zu erwarten, wobei hier eine schrittweise Einführung (zuerst unimodal, dann mit Terminal, danach mit Vor-/Nachlauf) bei einfachen Standard-Transporten (ohne manuelle Interaktion, kein Gefahrgut, keine Termingenauigkeit, etc.) als Wegbereiter für die künftige Anwendung auf komplexere Transporte sinnvoll ist.

Als mögliches **nicht-regulatives Incentive**, um den Zugang zu Daten, Informationen und zu existierenden Services in der Transportwirtschaft und Logistik als Grundlage für künftige Linking Services zu verbessern, wurden vor allem der zu erwartende wirtschaftlicher Nutzen durch das Anbieten der Leistungen der Beteiligten auf einer breiten internationalen Ebene identifiziert. Gemeinsam mit der zu erwartenden Kostenreduktion durch Effizienzsteigerung, basierend auf einem standardisierten Austausch von Informationen und Services, können Synergieeffekte genutzt werden, die eine Verringerung der Transportkosten ermöglichen. Ebenso können Linking Services als zusätzlicher Informations- und Absatzkanal genutzt werden. Durch die standardisierten, strukturierten und ständig aktuell verfügbaren Daten können laufend Optimierungsalgorithmen auf aktuelle Geschehnisse reagieren. Suboptima der rein internen Betrachtung können vermieden und echte Gesamtoptima unter Einbeziehung aller Daten der GeschäftspartnerInnen und Verkehrsinformationsdaten erreicht werden.

Um die **Bereitschaft zur Daten- und Informationsbereitstellung** an Dritte sowie die Nutzung von internen Services durch Dritte künftig zu erhöhen, müssen noch wichtige Rahmenbedingungen geschaffen bzw. geklärt werden. Dabei sollten zumindest Grundinformationen, wie angebotene Relationen, Fahrpläne, Standardpreise, Umschlagskosten, etc. der beteiligten Unternehmen angeboten werden, um eine Vertrauensbasis zu schaffen. Vor allem muss eine rechtliche Klärung der Verbindlichkeit von Angebot und Verfügbarkeit der Linking Services und weltweit gültige, nachweisbare Rahmenvereinbarungen zu Haftungsthemen, Versicherung, Zulassungen und Konzessionen geschaffen werden.

Bei der Abfrage der Einstellung der ExpertInnen wurde festgestellt, dass sehr viele mögliche NutzerInnen von Linking Services mit dem Begriff nur wenig anfangen können. Viele verbinden den Begriff ganz allgemein mit der Verknüpfung von Daten und Informationen zum Status von verfügbaren Infrastrukturen und Transportabläufen. Eine künftige Umsetzung von Linking Services müsste weltweit die gleichen Standards / Protokolle unter Anwendung von standardisierten Schnittstellen in Form von APIs (OpenAPI-Initiative) verwenden, um die Verknüpfung der dezentralen Services und Angebote anzubieten. Damit würde eine weltweit dezentral agierende „virtuelle" Spedition (System-of-Systems) geschaffen, die von der Auftragsanbahnung über die Vermittlung der eigentlichen Transportleistung bis zur Abrechnung der Leistungen (eigentlicher Transport, Nutzung der Linking Services, etc.) alle Prozessschritte übernimmt.

Mit der Verknüpfung kann die Qualität der Daten und der involvierten Services erhöht sowie eine nahtlose Informationsweitergabe ermöglicht werden, da immer auf aktuellste Daten und Informationen mit standardisierten

Datenprotokollen zugegriffen werden kann. Die notwendige Digitalisierung der relevanten Geschäftsprozesse in den Unternehmen erfolgt derzeit bereits bei den großen Unternehmen im Transport- und Produktionssektor und wird als Chance gesehen, um dem enormen Kostendruck entgegen zu wirken. Mit Linking Services werden monomodale Lösungen zu multimodalen verbunden, wodurch in Störungsfällen besser reagiert und zwischen den Transportmodi rechtzeitig gewechselt werden kann. Mit den beiden identifizierten Ansätzen zu den möglichen Businessmodellen („light" Version über Webseite und „professional" Version mittels OpenAPI und Blockchain-Technologie) zur Gestaltung von Linking Services könnten die bestehenden Ressentiments gegenüber der Weitergabe von Informationen und Daten an Dritte sowie der Nutzung eigener Services durch Dritte beseitigt werden und somit der bisherigen spärlichen Nutzung von Frachtenbörsen entgegengewirkt werden.

Weiters wurde festgestellt, dass Linking Services für die Transportplanung und -vergabe die bestehenden Vertriebskanäle (z.B. durch Bekanntgabe von Laderaumkapazitäten, Standardrelationen, etc.) bedingt auflösen, allerdings bestehende Nischen (maßgeschneiderte Lösungen für bestimmte Unternehmen oder Produkte) im Transportwesen nur schwer durch Linking Services abgebildet werden könnten. Für kleine Unternehmen würde sich allerdings eine Erweiterung ihrer Vertriebskanäle ergeben, da sie über Linking Services zumindest ihre einfacheren, standardisierbaren Leistungen auf weltweit nutzbaren Plattformen ohne großen Aufwand (Wegfall der Sprachbarrieren, etc.) anbieten können. Damit ergibt sich die Frage nach der künftigen Rolle von Speditionsunternehmen, da mit der Einführung von Linking Services künftig das Fachwissen in Bezug auf die Planung und Durchführung von einfachen Transporten in digitaler Form hinterlegt sein wird und deren Angebotsvergleich mit Algorithmen einfacher durchführbar wird.

Beim Einholen der Meinung der Befragten wurde festgestellt, dass nach deren Ansicht die Gefahr der Bildung von Monopolen besteht. Da Linking Services als Gratwanderung im Kartell- und Wettbewerbsrecht angesehen werden, ist es möglich, dass einzelne Branchenriesen starken Einfluss auf aufkommende Linking Services nehmen können und gleichzeitig das Aufkommen anderer unabhängiger Services bspw. durch ihre Marktmacht verhindern können. Dies ist speziell im Zusammenhang damit zu sehen, dass kleine Unternehmen aus wirtschaftlichen Gründen meist sehr rudimentäre IT-Ausstattung nutzen. Auch viele große Verlader sträuben sich, Daten über Schnittstellen bereitzustellen. Um sich an Linking Services zu beteiligen ist eine Ausstattung mit standardisierten Schnittstellen Voraussetzung, die sich Teile der Branche nicht leisten können. Dazu muss auch geklärt werden, welche Organisationsform zum Betrieb von Linking Services gewählt und wie diese überprüft werden können. Die Rahmenbedingungen müssen so gewählt werden, dass sich durch mögliche Zugangshürden, wie zu hohe Nutzungsgebühren, zu komplexe technische Voraussetzungen, etc. keine Communities bilden können, die Gruppen von Unternehmen ausschließen. Dabei darf auch die unterschiedliche IT-Reife der Unternehmen keine Zugangsbarriere darstellen.

Bei der Architektur von Plattformen zum Verlinken von Services muss der Datenschutz im Vordergrund stehen, damit keine Rückschlüsse auf das Geschäftsgebaren der Nutzer gezogen werden können. Um diesen kritischen Punkten zu begegnen, müssen gut geplante Informationskampagnen bezüglich der wesentlichen Funktionen von Linking Services deren Planung und die Umsetzung begleiten.

Konzepte und Business Modelle:

Basierend auf den Erkenntnissen aus den Interviews wurden anhand einer beispielhaften multimodalen Transportkette zwei mögliche technische und organisatorische Umsetzungskonzepte untersucht. Diese sind so abgestimmt, dass sie in zeitlicher Folge aufeinander aufbauen.

Das als **„light"** bezeichnete Konzept mehrerer Linking Service Plattformen sieht einen den teilnehmenden Unternehmen vorgelagerten IT-Servicedienstleister vor, der es speziell weniger IT-reifen Unternehmen ermöglicht, ohne große Änderungen und Investitionen in die existiere eigene IT-Servicelandschaft an der Welt der Linking Services teilzunehmen, wenngleich mit teils eingeschränktem Funktionsumfang, Zeitversatz bei den Daten und zusätzlichen Kosten. So wäre die Voraussetzung umsetzbar, dass alle an der Transportkette beteiligten Unternehmen in irgendeiner Form an den Linking Services teilnehmen. Dieser „Proxydienst" ist auch zur Nutzung über einen Webbrowser oder eine mobile App ausgelegt, kann aber auch über proprietäre bidirektionale Schnittstellen seinen Kunden zur Verfügung stehen. Ein erweitertes multimodales Routingservice könnte über die übliche Standard-OpenAPI mit diesen verbunden werden. Die Preisdarstellung und die Verrechnung der Nutzung dieser Linking Service Plattform erfolgt über einmalige Initialkosten, eine laufende Grundgebühr und eine Verrechnung über die Anzahl der Zugriffe („Pay per Click"). Dieses Service unterstützt den kompletten Transportportprozess von der Planung über Durchführung bis zur Bezahlung und etwaigen Schadensreklamationen. Es beinhaltet in der einfachsten Form den Vergleich von Richtpreisen (Tarife), Emissionen, Fahrplänen und Laufzeiten der angebotenen Relationen. Es können aber auch aktuelle Daten von Transport- und Umschlagsbetrieben bzw. Spediteuren eingegeben werden. Ebenso verknüpft es Services von Verkehrsinfrastrukturbetreibern und andere Dienste aus dem Bereich der intelligenten Verkehrssysteme (IVS).

Mit dem Ansatz „light" könnten auch kleinere Firmen schnell in die Systemlandschaft von Linking Services eingebunden werden, auch wenn sie keine eigenen Dienste und Services nutzen. Dabei können von diesen Unternehmen kostengünstige APIs angeschafft werden, die Grundfunktionen zur Einbindung in Linking Services bieten. Diese kostengünstigen APIs mit Grundfunktionen (Datenmanagement, Auftragsabwicklung, einheitliche Kommunikationsform, strukturierte Datensätze, etc.) sollten von einem Zusammenschluss der großen Systemhäuser zur Verfügung gestellt werden. Damit kann sichergestellt werden, dass auch kleine Unternehmen einen einfachen Zugang zu dieser Zukunftstechnologie haben.

Das als **„professional"** bezeichnete Konzept stellt in technischer Hinsicht den Nachfolger des „light" Konzeptes dar und teilnehmende Unternehmen nutzen eigene standardisierte API (Application Programming Interface) nach den Vorgaben der **OpenAPI**-Initiative zum Informationsaustausch (Auftragsdaten, Routinginformationen, etc.) mittels REST-Protokollen (Representational State Transfer). Dabei steht es den Nutzern (Transportunternehmen, Planungsplattformen, etc.) frei, ob sie eigene auf ihre Services (Individualsoftware) aufgesetzte OpenAPI-Schnittstellen nutzen oder API-Lösungen von Softwareanbietern einsetzen. Die OpenAPI-Schnittstellen bieten standardisierte Protokolle zum Datenaustausch an, wodurch es möglich wird bestehende Services mit verschiedensten technischen Architekturen und Datenformaten (Transportdaten, Frachtpapiere, Tracking/Tracing-Informationen, etc.) miteinander zu verknüpfen. Die API haben die Aufgabe Firmendaten und transportrelevante Informationen aus den unternehmenseigenen Systemen abzufragen, in die einheitlichen Protokolle (z.B. REST, wie in der OpenAPI-Initiative vorgesehen) zu übersetzen und die bidirektionalen Zugriffrechte zu regeln. Damit können kostensparend die Bereitstellung einheitlicher weltweit verwendbarer Daten ermöglicht werden und bestehende Services und Lösungen weiterhin genutzt werden. Weiters ist auch die Verwendung von Services, die in internen Systemen der Nutzer genutzt werden, durch Dritte möglich, da mit Hilfe der standardisierten API auch die Zugriffsberechtigungen gemanagt werden.

Die Umsetzung von Linking Services hat zum Ziel, dass die Vorgänge zur Abwicklung von Transportvorgängen künftig automatisiert ablaufen können. Um dies zu ermöglichen bietet sich der Einsatz von Blockchain-Technologie als Werkzeug innerhalb der Linking Services an. Damit können Linking Services auch von Beteiligten genutzt werden, die sich gegenseitig nicht vertrauen, da die Abwicklung der notwendigen Transaktionen nur schwer zu manipulieren ist und dauerhaft dokumentiert bleibt. Die Verrechnung der Nutzung sollte bei diesem Konzept durch die Implementierung von Blockchain-Technologien unter Verwendung von Token, die den Gegenwert der Qualität und Wichtigkeit der bereitgestellten Daten bzw. Services für die Abwicklung von Transportvorgängen darstellen, erfolgen. Dabei würden Inhaber von Token anteilig weniger bezahlen, wenn sie häufig qualitativ hochwertige Daten zur Verfügung stellen, die für die Abwicklung der Linking Services von besonderer Wichtigkeit sind.

Handlungsempfehlungen:

Für die Umsetzung der dargestellten Linking Service Plattform, speziell unter dem Einsatz von Blockchain-Technologie besteht allerdings noch großer Forschungsbedarf. Die großen Systemhäuser bieten bereits die ersten Tools für den Einsatz von Blockchain-Technologie in bestimmten Branchen, wie Versicherungen, Banken, Energiewirtschaft und für vereinzelte Anwendungen im Mobilitätsbereich an. Allerdings müssen kostengünstige Lösungen geschaffen werden, um die festgestellten Zugangsbarrieren für kleine Unternehmen zu beseitigen.

Auf Grund des hohen Investitionsbedarfes zur Digitalisierung der Unternehmen kann eine Umsetzung von Linking Services nur über geeignete international akkordierte Fördermaßnahmen erfolgen. Dieser Prozess muss von einem strukturierten und international abgestimmten Informations- und Meinungsbildungsprozess begleitet werden.

Um diesen Prozess koordiniert durchzuführen, sollte eine Vereinigung mit weltweitem Wirkungsbereich gegründet werden. Die Aufgabe der Vereinigung sollten sich auf folgende Punkte konzentrieren:

- Definition und eindeutige Festlegung der zu nutzenden Standards
- Abstimmung und Nutzung von Synergien mit existierenden Standardisierungsorganisationen aus dem Transportbereich (GS1 für Frachtverkehr (Containernummern, Barcode, QR-Code) oder TISA für den Personenverkehr)
- Promoten von kostengünstigen Softwarepaketen für kleinere Unternehmen, die von großen Softwareanbietern gemeinsam erstellt werden und Basisfunktionen für das Abwickeln von Transporten sowie die Anbindung an Linking Services über die standardisierten OpenAPI-Schnittstellen anbieten
- Entwicklung von Strategien zum Monitoring (Überwachen) der künftigen Linking Services in den Bereichen Einhaltung der rechtlichen Rahmenbedingungen Rechtmäßigkeit, diskriminierungsfreier Zugang alle interessierten Parteien, korrekte wirtschaftliche Abwicklung der Transaktionen, etc.

Zur Vereinfachung der Einbindung von Software in künftige Linking Services sollten Empfehlungen für die Architekturen von künftigen Softwareprodukten (Services für spezielle Anwendungen im aber auch außerhalb des Transportbereiches) erarbeitet werden. Dabei sollte die Softwarearchitektur eine system-orientierte Organisation des Austausches von Informationen und des Zugriffes auf interne Services unterstützen und bereits entsprechende Schnittstellen (OpenAPIs) bzw. deren spätere Implementierung vorsehen.

1. State-of-the-art in freight transport services

1.1. Introduction

According to DIN 30 780, a transport chain describes a "sequence of technically and organizationally interlinked operations in which persons or goods are moved from a source to a destination". A functional transport chain is a "sequence of transports, interim storage and transfer or apportionment processes. Single-unit, if no transfer or reloading is required apart from the first boarding or loading operation and the last boarding or loading operation; otherwise multi-unit (broken traffic). Reloading without the disintegration of loading units involves combined transport" (see [GablerWirtschaftslexikon2018]). A freight transport chain starts when an entity with a transportation demand charges an agent (e.g. shipping company) with a transfer order. In his turn, this agent charges further transport services and infrastructure providers, to be able to carry out the transfer order across one or more countries. This induces a chain of service providers and the application of several systems with different interfaces.

Several logistics service providers and shipment companies offer proprietary solutions for freight transport. The offered services comprise many, but not all, processes of the transport chain. Therefore, seamless services along freight transport corridors do not exist. Only proprietary solutions enable exchange of data and services in freight transport hubs. At this point, data exchange as well as linking and bundling of ready-made services can form the basis for a better management of loads along multimodal freight transport corridors.

"Linking services" represents a new approach in the context of freight transport. Linking services supports the communication between companies in industry, producing companies, logistics and transport service providers and commerce via standardized application programming interfaces (API). Not only relevant data and information is exchanged, but also access and usage of service-oriented architecture libraries (part of software code that solves special functions) in existing IT services is regulated via APIs (Application Programming Interface). After an authorization check, data from a service is transferred to the API of the selected service in a standardized format using standardized protocols (REST protocols as defined in the OpenAPI initiative). In this API, the access authorization is checked and the data for the selected partial service is prepared by the linked service. After processing the data in the service, the data is retransmitted to the requesting service.

Data sovereignty thereby remains within the participating company. The standardized interface controls the access to transport-related data and services of each involved company. These companies can outsource their service and data provision to a standardized platform using tailor-made interfaces to their own management software systems. The used APIs can also be released for companies not involved in the execution processes of a transport and their related services. These companies or users could, for example, be a data aggregation or an offer comparison platform such as "checkfelix.at" or similar platforms. This supports transportation planning and transportation allocation processes.

The concept of linking services in the mobility of goods provides for a decentralized approach, since these linking services are designed to connect existing services for specific user groups or tasks. These individual services could use common computer infrastructures but are usually conceived as decentralized systems. Risks during operation can thus be avoided. The failure of a centrally organized system would have an enormous impact on the transport industry. With the decentralized interpretation of linking services, which only have linking tasks, one could counter the potential weakness of a centralization of information and the feared loss of the USP (Unique-Selling-Proposition), which many potential users have identified.

There is one global standard for data and information exchange, which includes data protocols, data structures and data architectures. To take an actual example, new linked IT services can support or fully automate daily operations of transport planning, transport execution and transport completion.

To foster the introduction of bundled services, the study LiSeGMo ("Linking services for mobility of goods") has investigated and provided answers to the following questions concerning framework conditions in freight transport.

- Which barriers exist for data and information access in the transport sector and logistics?
- Which potential can be perceived for linking diverse services in freight transport?
- Which non-regulative incentives could improve data and information access in the transport sector and logistics?
- Under which circumstances are data owners and service providers willing to share their data with third parties?
- What could specific business models for cooperative data and information usage look like? Are there examples emerging from other sectors, where this concept has been successfully implemented?

Based on the experience of finalized and ongoing projects in the freight transport sector, project partners have described several concepts for combined resp. linked services in freight mobility. A specific case study of a process chain from freight transport has been worked out. Using this case study, the derived concepts are illustrated and thus made tangible and applicable for the freight transport sector.

To obtain a solid basis of knowledge and assessments from the stakeholders concerned, detailed expert interviews were conducted in a first round. These were used to obtain current opinions and assessments from companies and infrastructure managers. This included an initial assessment of:

- the willingness to use linking services,
- the willingness to pass on relevant data to third parties,
- the system and processes in use for transport processing and their technical possibilities for exchanging information,
- the possible hurdles,
- the estimated added value for the companies involved, and in particular,
- the possibilities of how stakeholders can be brought to enter cooperation within the framework of linking services.

To withstand competition, on the one hand producers are forced to make their processes more flexible, optimize them and adapt them to the new requirements. On the other hand, they must allow their customers to be as individual as possible. Therefore, in the coming years it will be a question of resolving the contradiction between resource efficiency and individuality. In addition to the catchwords "as soon as possible" and "just in time", which determine transport, there is also internationalization, which usually requires transport to be handled by all modes of transport (transport chain). It can be handled conventionally (truckload, rail wagonload, shipload) or in combined transport (container, swap body, cranable semi-trailer, rolling road).

The parts of the transport chains mentioned are usually processed by specialized companies. Depending on the size of the company, they either use tailor-made solutions for their own fields of activity (large companies), services that are offered on the market and, in extreme cases, no planning tools at all as with very small companies. Each of these solutions is an isolated solution that is usually not or only partially compatible with products from other system software providers or providers of other software.

1.2. Current status of planning and carrying out freight transports

There are driving forces that currently shape the European logistics market and will continue to do so in the next years. These driving forces include professionalization and efficiency, focus on core competences and effectiveness, service orientation, innovative technologies and faster ticking clocks, and they must be tackled for a successful business operation.

Logistics costs comprise up to 10 % of the potential sales of a company. The share of actual transportation is 4.5 %. In monetary terms, every kg of transported cargo costs around 1.5 € for logistics and around 0.7 € for transport [Davis2016].

Concerning cargo transport in Europe, road transport is dominant among all modes of transport. In 2015, roads accounted for just over half of all ton-kilometers transport in the EU-28. Maritime transport came next, with close to a

third of the total transport performance, followed by rail (12.3 %) and inland waterways (4.3 %). In terms of ton-kilometers performed, air transport plays only a marginal role at EU level, with a share of 0.1 % [EUROSTAT 2016].

Transportation of goods on the road is the only business sector in the field that can facilitate the existence and operation of SMEs. In comparison to all other modes, where investment and operational costs make it hardly possible for any other stakeholder than public ones or joint endeavors of big business players to enter the market, road transportation allows smaller enterprises to join in. This inherently creates a necessity to safeguard such initiatives as driving forces of employment, innovation and technology driven productivity, as the SMEs are most likely the main players to experience market fluctuations and potential shrinking [Stamos2018].

There is a marginal upward trend in the amount of goods transported on roads since 2012. The amount of transported goods (ton-km) has increased more than the transport mileage (veh-km). Hence, an increase of capacity utilization can be observed. This might be a hint for an already cultivated culture among transport operators towards cooperation and freight transport exchange. Therefore, technological solutions and innovation efforts should be directed to support this development.

Additionally, the multimodality of freight exchange should be facilitated and fostered. As different transport modes use different systems and different data structures, especially multimodal transport chains suffer from a lacking seamless information chain accompanying the transport chain (see [OEVG2016]). The information chain is important in a normal situation and becomes even more important in case of disturbances (e.g. late arrival of transport vehicles).

1.3. Current status of freight transport services (e.g., brokerage platforms and related activities)

Driven by technological trends and driving forces from the global market, several activities have been initiated to tackle successfully business operation. Smaller and larger international brokerage platforms have emerged on the private market during the past decade. At the same time, research projects and platforms have appeared in the public sector to foster cooperation and standardization. This section presents selected best practice cases and initiatives.

The following list of platforms and services currently available on the market for disposition, fleet management and the linking of transport-relevant information and data is only intended to provide a rough overview to get a better picture of the current situation. The list is by no means to be regarded as complete.

Transporeon

The TRANSPOREON brokerage platform links manufacturers, wholesalers and retailers with logistics service providers in over 100 countries: more than 850 connected Industry & Retail Companies, more than 65,000 connected Logistics Service Providers, more than 100,000 platform users [TRANS2018].

On its brokerage platform, TRANSPOREON offers three services (as SaaS solutions)

- TICONTRACT service for electronic tendering and cost management
- TRANSPOREON service for load assignment between shippers and carriers (fixed long-term contracts to variable contracts according to daily prices)
- MERCAREON service for incoming goods management at wholesalers or retailers: time slot management system shows available and booked times for making deliveries to the loading ramps at the retail company's distribution center or shop

TimoCom

TimoCom is a large European freight brokerage platform offering three services [TimoCom2018]

- TC eBid service for pan-European transport tenders: reaching a logistics network of up to 38,500 verified companies with one tender
- TC Truck&Cargo service for load assignment between shippers and carriers: up to 750,000 freight and vehicle offers are exchanged on the brokerage platform by more than 120,000 users from Europe (status 05/2017)

- Warehousing exchange service for companies looking for warehouse space or for companies offering empty warehouse space: based on either long-term contracts or short-term needs, offering access to up to 30,000 warehouse and logistics spaces spread across 44 European countries

Drive4Schenker

Drive4Schenker is a web-based freight brokerage platform operated by DB Schenker (see [DBSchenk2018_1], [DBSchenk2018_2]).

It offers a free service for carriers to improve load capacity utilization of transport vehicles. Currently, carriers get access to a marketplace of about 5,000 loads per day within Europe, comprising full and part loads. In addition, an app for drivers has been developed with an intuitive interface, which can be used to send driver status information, tracking information and Proof of Delivery documents. An improved payment process is expected to reduce the time needed from currently 60 days to 14 days.

An additional access point for small to mid-size shipment companies is planned. With the help of the brokerage platform, shipment companies will be able to directly negotiate load shipment with carriers.

Alpega Teleroute

Alpega Group is a global logistics software company that offers end to end solutions as Transport Management Services (TMS) and freight brokerage [Alpega2018]. The freight brokerage platforms Teleroute, Bursa and 123cargo serve as marketplaces for matching spot shipments and carrier capacities.

The platform Teleroute offers access to more than 200,000 freight and vehicle offers per day for shipments in EU countries. In addition, the platform offers additional information on the financial status and credibility of participating companies.

Imperial Freight Management System

Imperial Transport Solutions, a logistics service provider specialized in the sectors automotive, machinery & equipment, steel, retail & consumer goods and chemicals, introduced a web-based platform for inland waterway shipping which brings together shipping space and consignments [IFMS 2018]. Shippers gain access to a varied range of freight via an interface on a PC, tablet or smartphone.

The responsible dispatcher decides based on several different criteria such as reliability of the bidder, quality of cooperation, relationship of trust, freight price and transport time.

Uber Freight

Uber Freight is a logistics service provider since 2016, operating a dispatching center and a platform which matches shippers with carriers [Uber2018]. The interface to the dispatching system is accomplished via a free app which can be used by shipping companies to post their demand for a load and by carriers to book the load which they want to carry. Carriers can accept the price proposed for their service without the possibility or the need to negotiate the price, respectively. Carriers are paid for their service within 7 days.

Satiamo

ELOGATE is a software solution for managing tenders for carriers and dispatching for industry and retail companies [SATIAMO2018]. The software also supports calculation of the ecological footprint along the supply chain. It supports the transport execution processes and workflows.

It has more than 30 customers, mainly Austrian companies in the food, automobile, construction and pharmaceutical production sectors.

AEOLIX

AEOLIX (Architecture for European Logistics Information Exchange) is an ongoing H2020 research project (September 2016 – August 2019), which will develop a platform for connecting logistics information systems of different

characteristics, intra- and cross-company, for immediate (real-time) exchange of information in support of logistics-related decisions (see http://aeolix.eu). The ambition is to develop an architecture for a distributed open system which will exchange information among key logistics actors (commercial companies as well as relevant authorities), enabling increased use and impact of such information in the value chain. During the project, logistics related business issues have been selected as use cases to be researched at different Living Labs to validate and demonstrate the benefits of the platform.

The AEOLIX Platform support services will provide not only an additional tool through the dashboard (web application), but also a set of integration tools such as APIs (Application Programming Interfaces) and SDKs (Service Development Kits) to allow the integration of existing end-user systems or services and give the opportunity to develop new end-user applications. In this sense, the AEOLIX Platform provides SDKs (Service Development Kits) to develop or integrate software solutions or services for the AEOLIX Toolkit, enriching AEOLIX Platform services to help logistics stakeholders address the business needs of their processes or to request specific cloud services. Finally, AEOLIX provides APIs to enable the connectivity of services, apps or devices running on different platforms (Java, .NET, JS, etc.) to the AEOLIX Community Ecosystem in simplified technology integration. The AEOLIX platform provides a security framework based on a trusted model for cloud-oriented collaborative networks and security mechanisms (identity management, authentication/authorization mechanisms). It is aligned with EU directives and recommendations such as e-Identification and trust services described in the Digital Agenda for Europe and aligned with the Digital Single Market. The AEOLIX Platform will have three releases.

The platform releases of the AEOLIX project will initiate different engagement strategies for different types of stakeholders. The AEOLIX consortium partners have organized the first Platform Release 1.0 as a test fest event in Delft in October 2017 for shippers and service providers to check the initial requirements for connecting different proprietary systems through APIs and to demonstrate the quick wins. The first Platform Release 1.0 includes the development of the main functionalities of the AEOLIX platform (connectivity engine, dashboard, and toolkit). It further allows the basic data feeds to be visible in the dashboard and shows how the service providers can be connected via toolkit and APIs (see [Konstantinopoulou2018]).

FreightHub

FreightHub is a digital asset-free freight service provider located in Berlin (HQ) and Hamburg. The company's goal is to create the best freight forwarding experience for our global customers. Since its foundation in the summer of 2016, FreightHub established strategic partnerships with over 600 shippers and evolved into the leading European digital forwarder across sea- and airfreight between Europe, Asia and North America [FreightHub2018].

Wastebox.biz

Wastebox.biz (https://www.wastebox.biz/) is an app developed by the recycling company Saubermacher AG to organize a more efficient collection of waste materials on construction sites. The app offers the possibility to bring empty and pick up full waste bins spontaneously. After registration, customers can request construction site troughs or containers for the disposal of construction site waste directly via the app. Depending on the position of the requesting construction sites, this request is forwarded to nearby transport companies registered as partners. The partners commit themselves to continuously update the position of their vehicles and their status and can accept the order directly via the app. The order confirmation is sent to the person responsible at the requesting construction site. On collection, the requesting person confirms the collection and submits a quality assessment of the service of the collecting company. The service is then billed automatically. The app was launched in Austria and has been extended to Germany.

matchat.org

matchat.org is a platform developed in a current research project that concentrates on the linkage of social information on jobs, apartments and travel routes. Each participant declares a request to the community with his position and the selected thematic area or provides possible offers and answers in these thematic areas. Coordination of freight transports is currently not implemented but can be planned and coordinated via the included chat functions.

Common Telematics Platform® von Daimler Trucks®

Daimler Trucks' connectivity platform combines the electrical and electronic platforms of Daimler Group brands for heavy trucks (Mercedes-Benz Actros, Freightliner Cascadia and FUSO Super Great) into a single platform. The brand's own management systems, Fleetboard for Mercedes-Benz, Detroit Connect for Freightliner and Truckconnect for FUSO will be networked in such a way that the entire logistics of fleet operators can be managed. Furthermore, it provides an

overview of all relevant information for drivers and dispatchers. The platform also includes a "Fleetboard Store" for apps to obtain and to purchase new and complementary applications. These apps are provided for trucks by Daimler on the one hand and by third-party providers on the other hand.

RIO® von MAN Trucks®

RIO (https://rio.cloud/en/) is the cross-brand platform for all companies belonging to the truck division of the Volkswagen Group. The platform is based on the condition data obtained from the vehicles and makes these available to cooperating companies for processing and usage in supplementary services. These additional services are, for example, an ETA service (Estimated Time of Arrival) offered by Synfioo as a partner of the RIO platform. RIO is designed in such a way that all interested companies that offer possible services based on vehicle data or higher-level services (traffic information, etc.) have access to a data management service via predefined interfaces. Other services can use the data provided to generate additional information or make it available to other partner companies and services.

The services and platforms listed above offer a wide range of data, information functions and services developed for specific customer requirements or to optimize processes. As a whole, they are more or less isolated solutions. Linking services (see definition in chapter 1.1) have the potential to connect all these data and information sources and services via standardized interfaces (see OpenAPI description in chapter 4.2). The interface definition does not provide a so-called parser function for translating data formats and protocol. Standardized checks of access authorizations to data and partial services or software libraries must be contained in the services to be linked.

1.4. Excursion: Linking services for passenger transport

A parallel development can be observed for passenger transport and traveler information. Previous approaches to provide single access point information services for passenger transport have been solely based on data pooling. Providers of transport services contribute their data collections into a joint system – the data pool. Huge technical and personnel efforts must be undertaken by the operator of the data pool to achieve data consistency and integrity of the central system. Time consuming data harmonization processes must be installed, and proper change management is crucial to offer a high-quality information service on top of the data pool. Data exchange formats must be defined and often contributing providers have to bend with the proprietary data format of the central system.

Contrary service-oriented architectures distribute the burden of keeping data consistent on several shoulders. The efforts to harmonize data centrally are low compared to a data pool architecture. Linking services integrate information from several operators and therefore require negotiated static interfaces to guarantee a smooth operation of the information service. Contributing services need to operate 24/7 and must be highly available to meet the customer needs. Despite these efforts linking services and SOA can deal with different proprietary systems and contributing partners keep full data sovereignty as they provide services rather than data. Work on integration and standardization of traveler information has started more than a decade ago (e.g. EU-SPIRIT) and it is still ongoing (see i.a. ISO/TC 204/WG 10 on Traveler Information Systems).

Several finalized and ongoing activities aim at providing an integrated and seamless service chain for passengers' journeys. The information platforms are usually developed by transport operators at a regional or national level (e.g. SMILE application for Austria, TfL for United Kingdom), complemented by international activities to ensure the integration of services on a European scale (see i.a. TISA coordinated by ERTICO). All these platforms and services represent the starting point or the fundament of future linking services which link the information and offered services that are defined by specialized user needs or future markets.

BAYERN-FAHRPLAN

Bayern-Fahrplan is a Bavarian passenger information system based on the data pool DEFAS (Durchgängiges Elektronisches Fahrgastinformations- und Anschlusssicherungs-System), operated by the Bayerische Eisenbahngesellschaft (BEG) since January 1st, 2011. Timetable data contains real time information and incident information.

MOBIGUIDER

Kapsch CarrierCom provides solutions based on a platform called **Mobiguider** which is an example for the realization of linking services. It is an open system, integrating ticketing, Intermodal Transport Control Systems (ITCS) and Real-Time Passenger Information (RTPI) in a Service Oriented Architecture (SOA). It is based on the TRANSMODEL standard for public transport (http://www.transmodel-cen.eu/) and highly flexible in that sense that it provides customer-specific configuration and adaptations to future needs.

VAO

Traffic Information Austria (VAO - Verkehrsauskunft Österreich; https://verkehrsauskunft.at/) is a collaborative traffic information service of the highest quality for Austria that covers all traffic developments. VAO is offered as a separate information service and serves as the basis for the information services of the respective partners. It is a collaborative project of ASFINAG (coordinator), the working group of Austrian transport association organizers (ARGE ÖVV), ITS Vienna Region, radio Ö3 traffic editorial staff, the Austrian automobile, motorcycle and touring club (ÖAMTC), the City of Graz as well as the federal provinces of Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tyrol and Vienna. Co-opted partners are Austro Control for civil aviation, the Austrian Association for Rehabilitation (ÖAR), the Austrian Federal Ministry of the Interior and the Federal Province of Upper Austria. As trusted 3rd party, Austriatech ensures equal, non-discriminatory access to VAO for all interested parties and partners [VAO2018].

SMILE

Within the research project SMILE a prototype for a standardized platform for intermodal passenger transport for Austria has been developed. The open platform integrates offers from various mobility providers and it provides information on booking, payment and usage for a broad range of different modes of transport (see http://smile-einfachmobil.at). A smartphone app has been developed as a tool for the end user, which is in operation since November 2014.

EU-Spirit

EU-Spirit is an internet-based, cross-border travel information service for customers of public transport. It is based on existing local, regional and national travel information systems, which are interlinked via technical interfaces (https://eu-spirit.eu/).

The EU-Spirit service provides door-to-door travel information for customers who do not only travel within one region. The service provides the calculation of an itinerary between stops, addresses or points of interest in different European regions. The information service includes any carrier of local public transport and long-distance rail and flight services as well as additional services like map service and fare information. The information of the EU-Spirit service providers is for free and is provided via the customer's local information system in his mother tongue. Up to now, providers from the countries Denmark, France, Germany, Luxembourg, Poland and Sweden offer the EU-Spirit service.

TISA (Traveler Information Services Association)

TISA (Traveler Information Services Association) is a market-driven membership association with a worldwide scope. It is established as a non-profit company working on standards for traffic and travel information services and products based on existing standards, primarily RDS-TMC and TPEG™ technologies (see www.tisa.org). Open Traffic and Traveler Information (TTI) standards and policies are expected to increase traffic safety and efficiency of travel. TISA offers an environment where the values and needs of traffic and traveler information service providers, content providers, public authorities, car manufacturers, product industry, broadcasters and transmission operators meet.

The services listed above for passenger transport represent the basis for linking services. As an example of linking services, the so-called travel booking platforms, such as expedia.com® (www.expedia.com), trivago.com® (www.trivago.com), Checkfelix.com® (www.checkfelix.com), etc., can be mentioned in a broader sense as linking services. These online travel information platforms offer information in the field of travel arrangements such as flights, hotels, residences, rental cars, etc. in addition to the historical tasks of the websites (services) such as price comparison for hotel rooms or flights. When entering the search criteria, the customer selects all components of interest to him or her and states his general conditions for travel date and price expectations. Afterwards, the used web page searches by means of deposited services all offers. This is partly done over access to data bases maintained by the providers (airlines, hotels, rented car companies, etc.) and/or over tapping contents of the services of other providers, which correspond best to the search criteria. The results are displayed to the inquirer using appropriate display methods. If a suitable offer has been found, the customer can book it together with other selected travel components. The booking,

reservation, etc. runs in the background via the requested partial services. At the end of the process, the customer receives all relevant documents (booking codes, etc.) for the entire trip instead of booking the individual components separately.

Expedia.com® of the "expedia group" for example arranges individual services such as flights, hotel accommodation, rental cars and tickets for sightseeing as well as package tours. The platform also links information and services from other platforms or services specialized on different types of trips and travelers on the Internet. It uses worldwide existing global distribution systems or services like Sabre® (reservation of flights, hotel rooms, rental cars, etc.), Worldspan® and Amadeus® (for flight reservation).

These successful implementations of passenger information systems in the recent years drive further developments. Timetable data have been integrated very well. Real time travel information, incident information and recently also other services such as ticketing and on demand services are included more and more via linked service-oriented architectures. While pooled architectures often stop at nations boundaries (e.g. VAO, DEFAS), linking services facilitate cross border services.

Mobility of goods will largely benefit from the lessons learnt during projects in passenger transport. Data interoperability becomes service interoperability thus mainly depending on common semantics, which will require a lot more effort in the standardization of interfaces. The research project, IP-KOM-ÖV (http://www.ip-kom.net/projekt/), is an effort in that direction, for example, which defines ontologies and a standardized interface for public transport.

Business is easier when you speak the same language as your customers, suppliers and partners. Freight transport very often crosses international borders and in the vast majority of cases several companies are involved. The accompanying flow of information transcends company and system boundaries. International standards in data exchange would greatly simplify these processes. If also IT services could be accessed across companies, it would revolutionize the industry and create the basis for the physical internet. Organizations like GS1 have been dealing with these topics for many years. They should deal with the concept of linking services and could contribute a lot to the implementation through their experience.

2. Attitudes on linking services in freight transport

After analyzing international research projects and emerging IT enabled services on the transport market, expert interviews with Austrian representatives of the top management of logistics service providers, managing directors of transport and transshipment companies, a traffic infrastructure manager and a founder of an IT service provider in the field of digital freight tendering and transport execution support were conducted during the period of November 2017 to January 2018. The results of the open questions were used to obtain information on their attitudes towards linking services and barriers and potentials seen by the experts. A further focus of the interviews was a discussion on non-regulative incentives and the framework conditions needed to provide data for other companies involved in a transport chain. By the application of methods of qualitative content analysis by Mayring [Mayring2000] and after encoding the content according to Bortz/Doering [Bortz2006] the results were collated and analyzed methodically.

All persons mentioned in Table 1 except one have agreed in the interviews that their names, their position in their company, the company names and the main fields of activity of their company may be mentioned in the report. This statement was either part of the protocol or it was verbal accepted.

Table 1: Interviewed experts in alphabetical order

Name	Position	Company	Business Focus
Otto Hawlicek	Managing director	Container Terminal Enns GmbH	Container Terminal Operator
Nikolaus Hirnschall	Managing director	Roland Spedition GmbH	Container Operator
Jürgen Kratky	Sales manager	ÖBB-Infrastruktur AG	Rail infrastructure and terminal operator
Vanessa Langhammer	Head of digitization and process management department	Rail Cargo Austria AG	Rail based full logistics service provider
Andreas Pichler	Head of IT Services Administration / R&D / Innovation	Gebrüder Weiss AG	Full service logistics provider
Martin Schwaiger	Founder and managing director	Satiamo GmbH	Consulting and IT service provider in freight tendering and execution
Michael Fastenbauer	Head of Development & Innovation	Via Donau - Österreichische Wasserstraßen GmbH	Inland waterway infrastructure operator
Thomas Ziegler	Branch manager Linz	Schenker & Co AG	Full logistics service provider
(anonymized)	Representative of the top management	Wiener Lokalbahnen Cargo GmbH	Railway undertaking

Although new IT enabled services are on the rise and many practitioners are following the latest developments and trends, linking services was a completely new term for most of the interviewed experts. Many of them do not associate anything with it. Some explain it as a connection of data and transport processes, services or, generally speaking, offers. One expert mentioned "multi-stage transport" in this context. Another one described it as supply chain-wide service. One expert mentioned "FreightHub.com" as an example for a linking service.

To make sure everyone has the same understanding of the topic, a **definition of linking services** was given after the first questions:

"Linking Services" represents a new approach in the context of freight transport. Linking services support the communication between companies in industry, producing companies, logistics and transport service providers and commerce via standardized application programming interfaces (API). Not only relevant data and information are exchanged, but also access and use of software services is regulated via standardized APIs (Application Programming Interface). After an authorization check, data from a service is transferred to the API of the selected service in a standardized format using standardized protocols. Data sovereignty thereby remains within the participating company. The standardized interface controls the access to transport-related data and services of each involved company. These companies can outsource their service and data provision to a standardized platform using tailor-made interfaces to their own IT systems. The APIs used can also be opened for companies not involved in transport and their services. These companies or users are, for example data aggregation or offer comparison platforms such as "checkfelix.at", routing services used in passenger transport or similar platforms.

After providing a definition in the view of the study authors, some experts classified linking services as a threat for freight forwarding agents and their companies. Others recognize it as a digital evolution of this business model and a big chance for innovative established companies. Full logistics service providers already have implemented linking services in the form of proprietary closed systems. Many experts stated that they use IT services for transport assignment or sourcing like Transporeon, TimoCom or Drive4Schenker. Country-specific services are also used. Infrastructure operators could provide a cross border "meta data information platform" to connect data owners and data users in the future. Some of the experts stated that their companies do not use any of these kind of IT services at the moment.

The interviewees were asked to assess given possible weaknesses of linking services from 1 (not relevant) to 10 (highly relevant). The following values are:

- Min: The minimum value mentioned for the given strengths and weakness in all interviews
- Max: The maximum value mentioned for the given strengths and weakness in all interviews
- Mode: The most frequently mentioned value
- Mean: The arithmetic average of all mentioned values
- Median: Value located in the middle in the ordered data set
- Range: Difference from lowest to highest value mentioned
- Standard Deviation: The square root of variance

The representation takes place in the form of a box plot, which shows the rectangle spanned between the first and 3rd quartile, the minimum and maximum values and additionally the mean value.

A wider rectangle is a sign for large dissent in the group. A narrow rectangle represents a strong consensus situation.

Additionally, four of the five main research questions of this study were answered based on the further answers (open questions). The interview results are collected in the following chapters.

2.1. Barriers preventing from gaining access to data and information

The experts identified a whole set of weaknesses of the concept of linking services. In the following table, the estimations of all interviewed persons are listed and quantitatively evaluated.

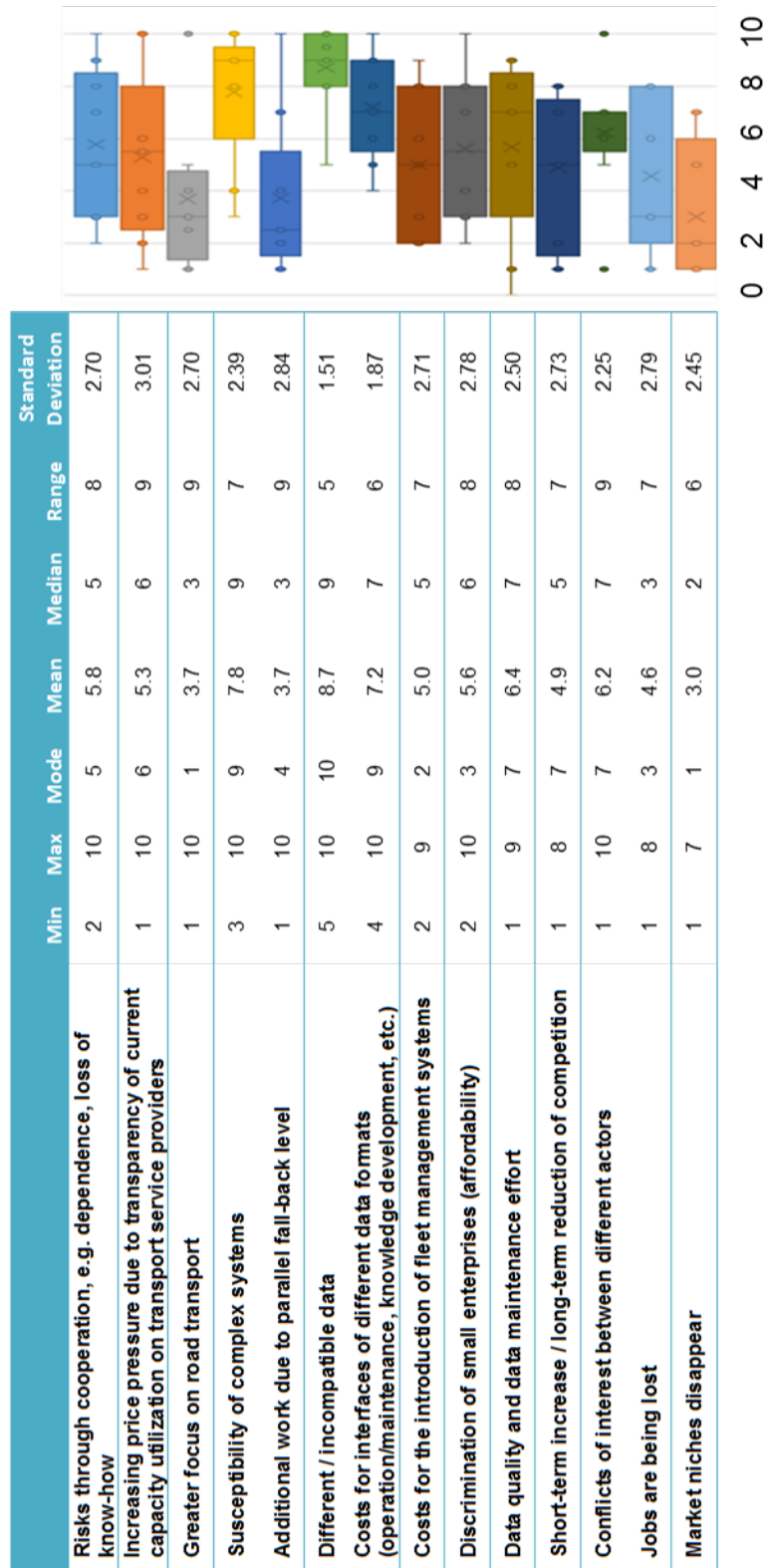|	Min	Max	Mode	Mean	Median	Range	Standard Deviation
Risks through cooperation, e.g. dependence, loss of know-how	2	10	5	5.8	5	8	2.70
Increasing price pressure due to transparency of current capacity utilization on transport service providers	1	10	6	5.3	6	9	3.01
Greater focus on road transport	1	10	1	3.7	3	9	2.70
Susceptibility of complex systems	3	10	9	7.8	9	7	2.39
Additional work due to parallel fall-back level	1	10	4	3.7	3	9	2.84
Different / incompatible data	5	10	10	8.7	9	5	1.51
Costs for interfaces of different data formats (operation/maintenance, knowledge development, etc.)	4	10	9	7.2	7	6	1.87
Costs for the introduction of fleet management systems	2	9	2	5.0	5	7	2.71
Discrimination of small enterprises (affordability)	2	10	3	5.6	6	8	2.78
Data quality and data maintenance effort	1	9	7	6.4	7	8	2.50
Short-term increase / long-term reduction of competition	1	8	7	4.9	5	7	2.73
Conflicts of interest between different actors	1	10	7	6.2	7	9	2.25
Jobs are being lost	1	8	3	4.6	3	7	2.79
Market niches disappear	1	7	1	3.0	2	6	2.45

Figure 1: Assessment of the relevance of the given weaknesses [1 not relevant; 10 highly relevant]

Derived from these assessments of weaknesses, interviewed experts mentioned the following organizational and technical barriers preventing them from using linking services.

Organizational barriers for data and information exchange:

Full logistics service providers whose utilization was already optimized, open their strategic and operative service network to competitors. Therefore, a suboptimum arises, which cannot be compensated in monetary terms. Companies very often hesitate to share their transport-related data with others. Very often, their customers are the data owners. As a logistics service provider, transparency carries the risk of losing profitable customers because competitors can identify and focus on them and can make better offers tailored to their needs and wants. Companies can lose their Unique-Selling-Proposition (USP) by sharing their data. Transport service providers offer their services tailor-made and, very often, so-called "value added services" are included. A competitor can simply generate an offer, when the processes, material volumes and weights are transparent.

Companies in the transport sector fear to make their daily business, their customer network and their costs and revenue structures transparent to others. That can lead to increasing price pressure due to competitor and customer pressure. Most of the companies in the freight transport sector will only publish transport-related data if a commercial benefit can be achieved (e.g., better utilization, fixed cost digression). No transactions will proceed without initial publishment ("Chicken-Egg problem").

Advantages are sometimes not the same for all participants, depending on the services offered. Suppliers in niche markets are struggling with more competition, but otherwise they can find new markets by using and participating in linking services. Forwarding agents become (partly) obsolete through the use of "linking services". Standardized transport services can be offered and procured automatically. In transport execution, process data and service access for participating partners can build the basis for automated vehicle disposition, resource allocation and sequence planning. This could lead to social problems.

Algorithms will play a key role in business success – software companies will take over the forwarding market. Experience and having the big picture of the transport and logistics service market will become less important than is the case today. Today most transactions were concluded bilaterally between two trading participants. Companies see no necessity to share data via open application programming interfaces (OpenAPI). Logistics service providers are mainly interested in fostering long term relationships (contract logistics) with shippers vice versa. Customer relationships decline because of automation and digitization. Trust and good experience with partners could become digitized by customer evaluation systems and quality assessments based on transport-related data analysis.

Today there is a lack of standardized conditions of cooperation, liability, data protection, competition and cartel law for doing business via linking services. A framework for cooperation must be established. General agreements have to be contracted. Producing and trading companies own the transport-related data and prevent the sharing of these information. There are apprehensions that other companies could extract conclusions about production and sales figures based on transport data. Large companies fear effects on their own share price.

Continuously updated transport data has to be provided, which requires a greater expenditure in terms of time and technology. Linking services lead to higher demands and standards in IT maturity and IT service management. Freight companies, producing and trading companies are reluctant to invest in IT systems. Very often they do not want to replace or adapt their existing IT solutions. Additionally, they do not want to have to deal with additional APIs and data security issues. Lock-in effects and strong IT service operator monopolies are to be expected. Data sharing and data access control requires trust and a neutral operator, who is not an active participant in the transport market, acting with their own operating resources as a competitive player. Initial costs of APIs and IT systems, employee training courses and a strong process integration are lock-in effects that companies wish to avoid (change costs are to be considered).

Technical barriers for data and information exchange:

Many smaller companies have poor conditions regarding their internet connections or access to mobile communication and little expertise in data interfaces. Especially in many industrial areas where transshipment points and logistics service providers are located; the internet connection is mostly slow due to the limited broadband access. IT resources are often limited, and the IT maturity is sometimes frighteningly low. IT has so far not been such an important cross-sectional function in the transport industry. Paper documents, fax and email are still frequently used. Leading logistics service providers, on the other hand, have been using highly developed software solutions for years.

Many interfaces increase complexity and costs. Some companies in the transport sector have integrated software solutions with important customers and partners via APIs. They very often use individual customized software or specific branch software suites without standards for interfaces, data structures and protocols. Quality of data and incompatible data structures are major problems. Different data standards exist for different modes of transport. Logistics and transport service providers have troubles getting data in usable form (data structure, including all relevant attributes and protocols).

There are serious doubts concerning IT security, especially when data from other companies is used. Due to the general data protection regulations, there is currently a great deal of uncertainty among companies regarding these issues. Reports of companies that have been hacked are increasing. Hacker attacks are expected, because entire regions could be attacked and "knocked out". Being dependent on IT solutions scares many people in the sector. The dependency on IT specialists is growing, while at the same time there is still a lack of employees in this field. The trend towards digitalization is heating up the situation on the labor market.

Transport services are often tailor-made and unsuitable for standardization and linking services. Especially value-added services processes are difficult to support with data standards that are as generally applicable as possible. Freight goods very often have special characteristics (e.g., sensitive fragile goods, stackable, bulky goods, etc.), which make them unsuitable for standardization and linking services. As many peculiarities of the transport industry as possible must be adaptable to standards

2.2. Potential for linking services and fields with the highest potential

The experts identified a set of strengths of the concept of linking services. In the following table, the estimations of all interviewed persons are listed and quantitatively evaluated.

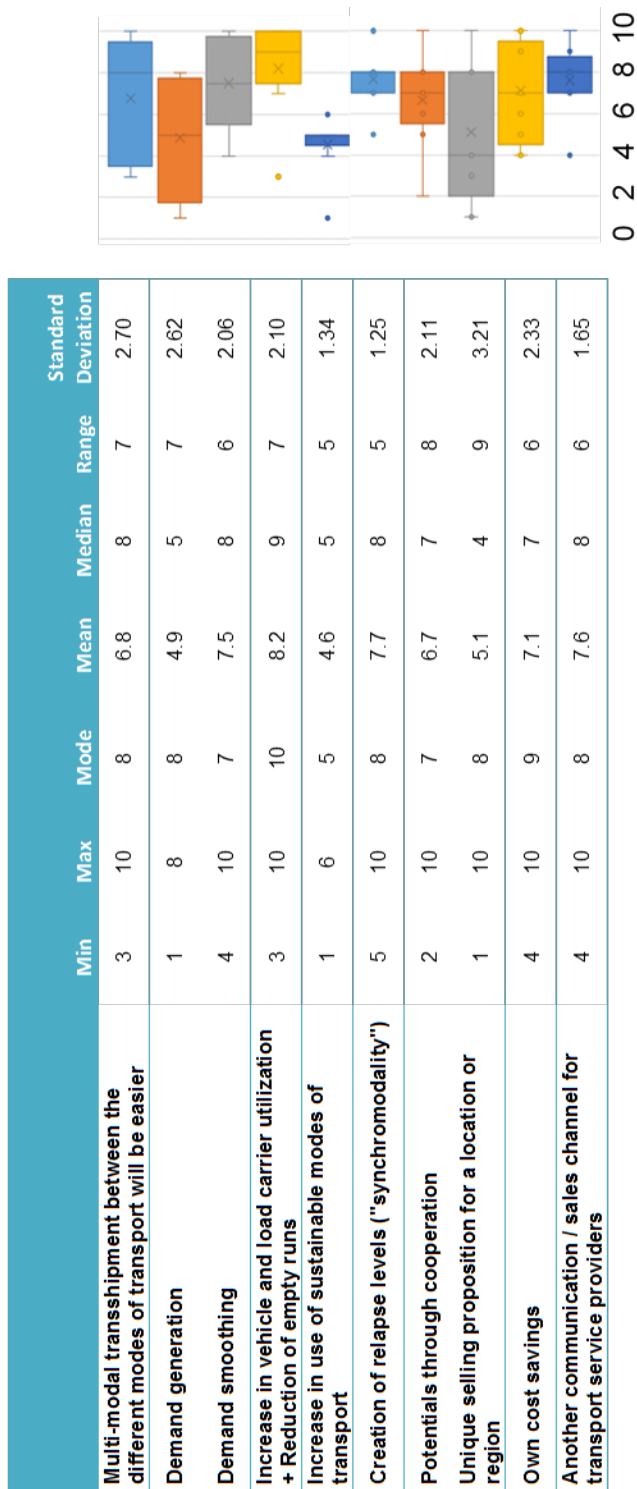|	Min	Max	Mode	Mean	Median	Range	Standard Deviation
Multi-modal transshipment between the different modes of transport will be easier	3	10	8	6.8	8	7	2.70
Demand generation	1	8	8	4.9	5	7	2.62
Demand smoothing	4	10	7	7.5	8	6	2.06
Increase in vehicle and load carrier utilization + Reduction of empty runs	3	10	10	8.2	9	7	2.10
Increase in use of sustainable modes of transport	1	6	5	4.6	5	5	1.34
Creation of relapse levels ("synchromodality")	5	10	8	7.7	8	5	1.25
Potentials through cooperation	2	10	7	6.7	7	8	2.11
Unique selling proposition for a location or region	1	10	8	5.1	4	9	3.21
Own cost savings	4	10	9	7.1	7	6	2.33
Another communication / sales channel for transport service providers	4	10	8	7.6	8	6	1.65

Figure 2: Assessment of the relevance of the given strengths [1 not relevant; 10 highly relevant]

Derived from the identified strengths shown in Figure 2, the interviewed experts stated the following potentials of linking services.

More and earlier available data and information together with increasing standardization will lead to the simplification and improvement of processes in transport planning and tendering. This fact brings general savings related to business processes. The complexity and difficulty of day-to-day business will be reduced for employees. Linking services lead to easy to handle transport optimization in terms of costs, environmental impacts, etc. A much larger number of offered services can be compared automatically and an optimal solution can be found more quickly.

Linking services promote sustainable transport modes and means. The increased complexity of intermodal transports compared to simpler unimodal transports can be compensated by algorithms based on the data now available. They also offer an approach to efficiency improvements and cost reductions. Empty runs can be reduced, resources can generally be better utilized, and constantly running optimization algorithms can respond to unforeseen situations on the traffic infrastructure or the transport market and help to continuously improve transport planning.

Standardized data interfaces enable an approach to process automation, less input errors and quicker responses. In general, this is expected to accelerate all business processes. More transparency leads to a better interlocking of processes (e.g. production and distribution of wares). Downtimes in production due to overloaded goods issue areas can be avoided or better handled. Resources can be better allocated.

Shipping companies will have access to a huge market of logistics and transport services providers via linking services. This can lead to insourcing of transport-related planning and disposition activities and more price pressure in logistics purchasing. The comparison of prices will be easier because of the standardized services. This will also generate more price pressure in the transport sector. Logistics service provider can make the best use of this circumstance for themselves in easily offering and tendering services.

Linking services represent an additional sales channel for logistics and transport service providers. It is important not to miss the right moment for market entry. Standard requests for service offers can be done automatically. The reachable market is enlarged. The handling of the countless offers received afterwards is feasible. Linking services will offer an additional information channel in the transport market (information). Market transparency can lead to greater use of less busy times and modes of transport for planned transports stimulated by more favorable conditions. Linking services will offer an additional procurement / distribution channel for transport services (transactions). Especially road haulers can handle incoming orders directly from shippers without the need of an intermediate transport agent via linking services.

Linking services can be used to control or regulate transport and traffic flows and could improve the modal split via a routing algorithm. Regulatory interventions in routing algorithms can contribute to an overall optimum of the entire traffic system. Linking services also support dynamic pricing and may lead to smoothing of peaks in traffic volume on public roads and on company sites. Dynamic pricing for transport infrastructure usage and dynamic service fees for transshipment can lead to these effects.

The experts discussed the areas of freight transport with a special suitability towards linking services very controversially and subsequently rated almost all the given areas as suitable in one way or the other.

- Multimodal transport chains
- Unimodal transport (e.g., time slot dependent loading)
- Small and medium enterprises (SME) logistics providers
- Contract logistics services
- Transaction-orientated transport spot market
- Simple transport orders (no dangerous goods, no punctual delivery, etc.)
- First implementation as a human-machine collaboration service. In about 10 years these services will become machine-to-machine services.
- FTL (Full Truckload) transport
- LTL (Less Than Truckload) transport
- Regular transport service
- Information service for shipping companies
- Booking service for logistics and transport service providers

Some experts agreed that linking services have the potential to increase the efficiency of transport because:

- linking services can provide information and data on a long-term basis (central data storage)
- linking services can replace transport agents
- "less-than-truckloads (LTL)" have potential for optimization (imbalance in trade flows, avoiding empty mileage)
- in the final expansion stage, the whole branch will use linking services, thus exploiting all synergies.

Others disagreed, because:

- the cost pressure is very high already and return on sales is about 3 %. Therefore, there is little room for improvement.
- larger full logistics service providers are operating their own closed systems of linking services and are optimizing their business processes already
- individual business transactions have special requirements and can't be digitalized / standardized

2.3. Non-regulative incentives

Companies are business-driven. Therefore, it is not surprising that commercial incentives are most frequently mentioned in the interviews to contribute to linking services. The experts have identified a list of non-regulative incentives:

- Commercial benefit / additional business due to linking services: As an additional sales channel, linking services should lead to further orders and thus to higher revenues.
- Services solve many problems concerning legal certainty on an international basis: Fundamental agreements and international standardization of processes, data access, service quality and liability issues eliminate ambiguities.
- There must be potential business partners using the data and services to have an incentive to share and offer. Undefined user groups and competitors interested only in the data represent the opposite.
- Cost reduction/ savings and efficiency enhancement due to standardization. Automatic data transfer leads to fewer input errors.
- Taking advantage of synergy effects (resource savings and better utilization). Less than truck-loads can be bundled. Downtimes can be avoided.
- Automatic calculation and certification of environmental impact of the transport chain. This is an interesting value-added service for many companies involved in environmental projects and pursuing sustainability goals.

The situation has changed in some companies. Some years ago, sharing transport-related data was unthinkable. Today these rigid attitudes have softened. Standard price lists, price calculators and even information about the current availability of operating resources and services are published on company websites. Price transparency and dynamic pricing are instruments to make order peaks easier to handle.

Additionally, some advantages of possible applications of linking services are listed in the literature.

Advantages of electronic tendering and cost management via a freight brokerage platform:

- Creating very complex tenders in little time
- Reliable access to up-to-date freight rates
- Possibility to create a company profile to receive invitations to bid for tenders with the right fit for a company
- Quick and easy solicitation of quotations from carriers
- Tenders may be analyzed at the end of the process

Advantages of load assignment via a freight brokerage platform:

- Easier access to information on demand by shipment companies and transport capacity offered by carriers
- Transport assignment based on transparent criteria contractually defined between shipper and carrier, such as freight price or quantity commitments (necessary condition: both price and quotas are contractually agreed between the shipper and carrier in advance)

- Flexible load assignment with information updated daily: shipments and freight space scheduled based on the carriers' latest prices for a day and their associated offers
- Paperless logistics: reduction of process costs and reduction of telephone costs
- Detailed and fast transport data transmission (e.g. driver status information, tracking information, Proof of Delivery documents)
- Potential for better capacity utilization / less empty runs
- Faster payment of carriers and drivers

Advantages of time slot management via a freight brokerage platform:

- Transparent delivery status
- More transparency in inbound goods
- Faster unloading process, increased volumes processed in inbound goods
- Guaranteed delivery times
- Fewer peak times
- Targeted manpower planning – in step with incoming deliveries
- Evenly spread utilization of loading capacity
- Shorter idle and waiting times for carriers, better use of breaks and rest periods

2.4. Basic preconditions for data owners and service providers to share data

To be accepted and used by practitioners, linking services should fulfill framework conditions. In the interviews, some topics have been discussed very controversially. The main outcomes are listed below:

- Linking services need to be operated or supervised by neutral and independent bodies to ensure non-discriminating service. Otherwise if the operator is a competitor on the logistics service provider market, it is feared that the data provided could be used primarily for own purposes (customer solicitation).
- A standardized data interface is necessary because of the size of the transport service market. Otherwise, one would have to maintain a huge number of interfaces to be able to use linking services.
- Some experts prefer a gradual implementation of linking services starting with certain applications. The introduction of linking services would be easier. A parallel operation is associated with additional costs.
- Other experts prefer a complete introduction of linking services for the whole transport chain, which shortens the rollout phase, but fallback plans are difficult to implement.
- Some experts prefer an introduction of linking services used via manual data input forms. Initial costs and barriers to participation are low. Even small companies can participate. To handle a transport from start to end, all partners have to participate.
- Some experts prefer an introduction of linking services using automatic data interfaces (Web-API). Input errors are minimized and most of the advantages of linking services can only be fully used via API.
- Only basic price conditions of requested transport services should be provided (transport relation, the size of the goods which are to be transported and a possible time demand, regular costs of container lifting, etc.).
- Specific data shall under no circumstances be passed on to uninvolved third parties. Data access control is probably the most important function in the interaction of the many stakeholders.
- Shipping companies are data owners and decide on data transfer via linking services. Very often they are only in contact with the logistics service provider and appreciate this single point of contact that manages everything including the flow of information in the background with all its subcontractors and partners. As data owner, the shipper must decide on the persons allowed to access which data for how long and must ensure that this is also reflected in the linking services. This additional administrative effort can be reduced with simple standard rules. Only potential and existing customers should have access to the provided data. It should not be possible to use the linking service architecture and the IT services offered therein as a general open information platform, for example to provide competitors, journalists or stock exchange analysts with the current database.
- It is necessary to establish a consistent reference number for single transports processes. All those involved in the transport chain can thus gain access to the data they need via data access control.
- Data sovereignty remains with the participating company. Only usage of data is available to all.
- Legal clarification of binding character (offers) and liability. Business relationships require clear actions and transactions with correspondingly legally binding effect.

- Data protection must be guaranteed. It is already difficult to convince companies to make sensitive data available online. Only with the provision of order-specific data can all the advantages of the linking service approach be realized.
- Linking services have to offer legal security and warranty including insurance. Otherwise, no legally valid transactions could be concluded between shippers, logistics companies and transporters. The cargo cannot simply be handed over to someone without clarifying liability issues and excluding criminal acts.
- Technical assurance of availability, integrity and confidentiality of data are crucial. Any criminal actions do not have to be made possible in the first place
- Consistency and uniform standards must be used. Otherwise, many bilateral individual solutions would arise and undermine the concept of linking services. This would certainly lead to a setback in the form of rigid trade relations.
- Customers must accept it and have to deal with it. As everywhere, the transport industry is customer-driven. Ultimately, he or she decides how the business relationship is to be handled.
- "Quid-pro-quo": Everyone benefits, otherwise no one takes the first step. Finally, costs are also associated with the entry and use of linking services.
- Level of automation: It should not become a "fight of the software engineers". Algorithms have the potential to decide on orders and finally the corporate success like software-driven stock trading. You do not want to expose yourself to this, because perhaps your own IT competence may not be sufficient.

First of all, general cooperation agreements between the collaborating participants in a transport chain must be concluded (means of operation such as a freight train may be taken over, possession of a license and insurance, etc.). Infringements must be punishable on international level.

3. Concepts for contributing to or participating in linking services in freight transport

This chapter describes existing strategies and concepts of managing the exchange of information and services of companies involved in the transport branch. The described concepts should be analyzed whether they have a proper architecture to participate in future linking services.

Linking services should link existing services and information systems as described in the definition in chapter 1.1. This is to be done via new superordinate architectures (see "Linking service with special scope or application 1" in Figure 3). This means that only players in the freight transport sector ("Company 1 to x") who already use their own services or management systems can be addressed directly. Companies in the freight transport sector have very different levels of IT maturity. Some of the existing services and systems were developed by the companies on their own or were purchased from many software providers. For economic reasons, existing systems have to be used when establishing linking services and should be connected via standardized interfaces (e.g., OpenAPI using REST protocols). This is especially to be considered under the aspect that not everyone is forced to invest in new systems or software solutions to be able to use linking services. This could counteract a failure of the concept idea of linking services for economic reasons.

A linking service requires a new architecture that can connect existing services and systems (see OpenAPI C1 to Cx or OpenAPI T4 in Figure 3) via standardized interfaces (see "Linking service with special scope of application 1" in Figure 3). OpenAPI C1 to Cx or OpenAPI T4 are docked interfaces to the existing services, which are either provided as add-ons by the software providers or created by the participants themselves. Internally, the REST protocols used by the OpenAPIs are translated into the internal protocols used by the service to be linked. This ensures that, regardless of the used service or tool, communication is always based on uniform data and information. Authentication and authorization checks have to be integrated in the OpenAPI interfaces to ensure data sovereignty for the individual participants. The mentioned standardized interfaces should not only be offered for existing transport management systems, but also in the form of simple and inexpensive solutions for small companies. This enables small companies to participate in linking services at low cost.

The major system software providers (SAP®, IBM®, Qualcomm®, etc.) should offer corresponding solutions for their products. This will achieve a standardized information exchange for the application within the framework of linking services to the market via existing customers. In this way, experience can be gained in the initial phase and appropriate solutions can be offered to new customers. With the increasing demand, as already mentioned above, tools with minimal functions for participation in linking services could be developed by the system software providers for small companies to generate a larger number of users.
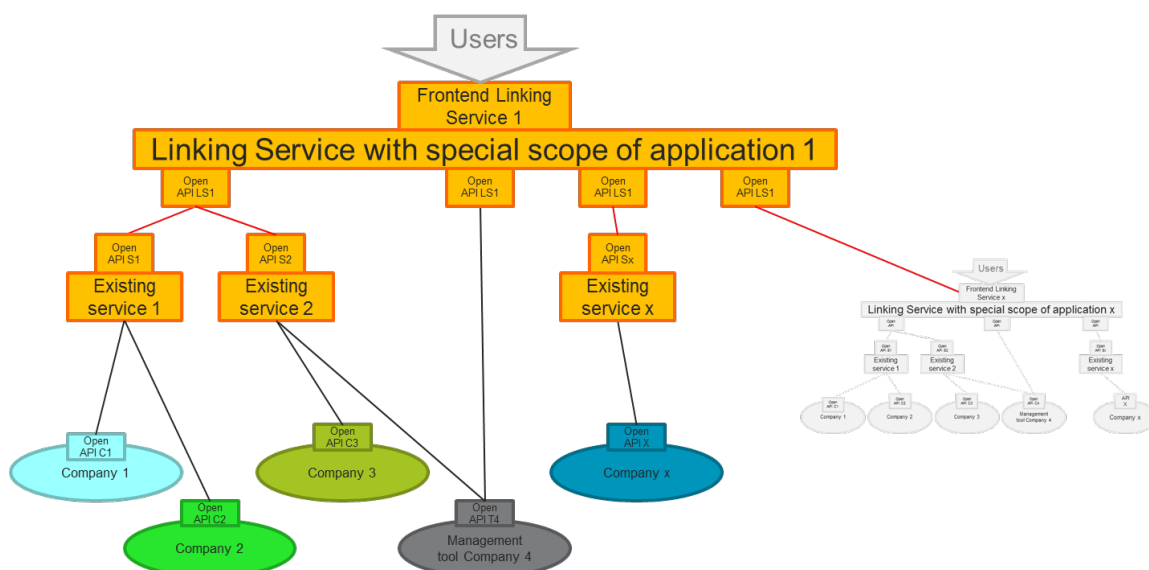

Figure 3: Example of an architecture for linking services including a connection to another linking service

The lessons learnt from the reviewed best practice cases show that there are several possible ways or concepts to link services, both for a traveler information and for a freight transport service chain. Constituting a good starting point for concept development, a recent study by the Rail & Road Traffic Management Working Group of the ÖVG (Österreichische Verkehrswissenschaftliche Gesellschaft) has identified four possible strategies to achieve a seamless information chain for customer services (see [ÖVG2016]). Based on these considerations, the best fitting architecture should be identified as a role model of how the framework of future software solutions should look like to ensure the involvement in linking services.

3.1. Concept 1: Internal organization of transport related information exchange

Regardless of its size, each enterprise sets up an organizational structure which monitors each shipment and organizes trouble shooting and customer information in an optimal way. This ranges from a single carrier as sole trader to a whole unit in a large enterprise, e.g., an ocean carrier. The client receives information directly from a person or an information system like a web interface.

Preconditions:

Each company has an appropriate organizational structure based on internal processes for monitoring, trouble shooting and customer information to ensure a stable process of quality assurance regarding information and data quality. All information, meaning data of or services for each customer are defined in individual agreements including when and how frequent which information should be reported to the customer. The collection of the agreed information or services is mainly based on tracking and tracing services using internal data.

Advantages / incentives:

The customer information and all offered services are part of the product. It fosters the customer loyalty and may be decisive the competition against other service providers. That preserves the relationship to each customer mainly based on a personal contact between the service provider and his client for specifying requirements and priorities on how to handle the shipments. The service provider has no need to invest in complex communication technology if the client agrees with the lowest level of communication (telephone). The quality of the customer information and the offered services stays within the company`s own area of influence. The service provider can choose the form of tracking and tracing of shipments itself and maintains its data sovereignty.

Disadvantages / barriers:

The service provider will get no contracts if the customer requirements cannot be fulfilled due to a lack of functionality of the offered services. He can only meet the customer requirements by investing in increased functionality of its offered services. This step is also required if the service provider is obliged to track a shipment as part of a new contract with an existing customer and has to set-up additional tools for maintaining the needed information and services (tracking/tracing, monitoring) of his costs. The concept of internal organization of information exchange is in its architecture not very flexible to react on new customer requirements or to cooperate with external services. An involvement in linking services is only achievable by investing in the implementation of standardized interfaces like OpenAPIs. If the service provider is not able to make this investment he would not get involved in future linking services.

Participation in linking services:

The participation in linking services can be arranged either by the company itself or by a service provider. This service provider can, for example, manage the data and information regarding the planning and execution of transports for small companies in the form of a bookable service. Due to the size of the service provider (number of its customers) it has the possibility to purchase and operate solutions for the access to linking services (OpenAPIs) from big software providers more economically and to make them available to its smaller customers. This will allow greater access to future linking services.

On the other hand, companies with their own software solutions can either make the data and information available to a linking service via their own interfaces connected to an OpenAPI or they use a service provider who prepares the relevant data and exchanges it bidirectional with linking services via the OpenAPI of the service provider.

3.2. Concept 2: External organization of transport related information exchange

A neutral, internationally operating company ("Third Party") supervises the whole intermodal transport chain and is responsible for the exchange of services and customer information. The service provider is responsible for trouble shooting based on the information of the supervising third party. He has created its own tools for the management of transport or uses solutions from major software providers. The connection to linking services can be managed with standardized interfaces created for the in-house software or via the third-party information service provider and its OpenAPI.

Preconditions:

The third-party service provider should be a neutral, internationally operating supervisory body which uses an agent-based system with strictly distributed rights concerning data storage and access of all parties. Another precondition is the existence of accorded internal processes for communication between service provider and supervisory body for handling of the mandate to supervise a shipment and the information strategy in case of trouble shooting. It is also necessary to regulate the definition and implementation of interfaces between supervisory body or authority and service provider. This includes the definition of common data format (contents and data structure) and the requirement of a unique shipment identification. Ideally, each shipment is equipped with tracking hardware to provide real-time tracking and tracing information. This requires a logistic concept to carry the tracking and tracing hardware to the starting point of the shipment and to supply it with energy.

Advantages / incentives:

The external service provider offers a common information quality for all customers due to the technical set-up of the information exchange platform. Based on the tracking obligation as part of the business contracts between the external supervisory body (third party) and the transport service provider (shipper, forwarder, etc.), the information on all shipments is always up-to-date. All this information is made available by only one entity that monitors all shipments of each customer along the whole intermodal transport chain.

Disadvantages / barriers:

The external company or party monitors and manages all relevant information about the shipments and their exchange with the customers. This is only applicable by using fixed sets of tools. Customized exchange of information is not part of the product and may not decide the competition (generalization instead of individualization). All service providers, even small enterprises, must invest in hardware including the needed logistic to ensure the operation (provision of adequate new units, spare parts and power supplies) and software to use this concept of information management strategy. Another disadvantage is the fact that both the service provider and the supervisory body have the data sovereignty regarding to the information they provide or generate during operation. On the one hand, the supervisory body may be considered as trusted third party, but on the other hand, the supervisory body may become a cartel (monopoly) concerning information exchange due to prescribing common data formats (shipment IDs, etc.) and the obligation to use one certain tool set or system. This would cause a massive competitive disadvantage when the service provider or company is not able to use this system.

Participation in linking services:

The participation in linking service can be executed by the supervisory board due to the implementation of OpenAPI interfaces to provide internal information and other services. The exchange of the internally used services for the processing and preparation of the shipment information can only be provided after clarifying the authorizations in the OpenAPI to use the data or services in both directions of communication.

3.3. Concept 3: System-oriented organization of transport related information exchange

As there are many different systems for monitoring shipments and traffic state and for providing customer information, standardization of system interfaces has a good potential to provide a solution. Standardization is one of the cornerstones of the "Physical Internet" for logistics services. It can be accomplished by means of a standardized

intermodal customer portal which can be individualized for service providers and clients. This concept is supported by ALICE (Alliance for Logistics Innovation through Collaboration in Europe, see [ALICE2016]) and the intermodal freight platform AEOLIX (see http://aeolix.eu).

Preconditions:

A system-oriented organization of information and service exchange depends on the standardization of interfaces and data formats. Existing information exchange platforms often use their own internal interfaces, data formats and protocols. These systems work stand-alone serving the participants with predefined services and information to fulfil the objective targets of the platforms (provider searching service, supply and demand service, etc.). However, to connect these stand-alone systems standardized interfaces must be set-up to enable a regulated exchange of data and services with similar systems or platforms. As another precondition, a worldwide unique shipment ID according to unique container IDs in combined freight transport has to be created to trace all shipment activities and transactions with additional services. A uniform business model must be established to manage all transactions (information exchange, usage of procurement of shipments, etc.) between the existing systems or platforms. It is also necessary to have defined non-profit organizations which are responsible for the operation of data and service centric platforms for international (world-wide) logistics services that will be linked in the future.

Advantages / incentives:

Existing systems and platforms offer mainly a high degree of automation to collect and extract data and information with the help of tailor-made services. Thereby, the available information quality is independent from single enterprises or employees by using fixed and uniform protocols. The system-oriented organization of information and service exchange allows an intermodal and international applicability execution.

Disadvantages / barriers:

The individualization of the information or service exchange is hard to implement and can only be reached by tailor-made "translating" tools to match the external information or services with internal tools of the involved systems or platforms. This can be managed with interfaces of the OpenAPI initiative which include the translation functions between internal data structures and services and external uniform protocols as a connection to linking services on a higher level. These tailor-made OpenAPIs cause system costs for all service providers and participants. Especially small enterprises will be confronted with investments that are necessary to stay involved in future business.

The exchange of information and data as a result of using automated interfaces will cause a reduction of personal customer relations which represent the USPs of companies in the transport sector and the basis of their daily business.

Participation in linking services:

The system-oriented organization of information exchange uses an architecture that is based on different existing services and tools to operate specific use cases regarding the transport of goods. These services offer the opportunity to participate in linking services after the implementation of standardized interfaces using OpenAPI standard protocols. With this, the uniform interfaces of key function of linking services and a broad range of specific duties in freight transportation can easily be accomplished.

3.4. Concept 4: Process-oriented organization of transport related information exchange

A further option for achieving a seamless information chain is to apply a standardized process to all involved participants. This concept is focusing on the digitization of existing processes to achieve a single standardized process for the exchange of information and services over all activities regarding supply chains and transport duties. The standardized exchange process works with a "decision tree" that represents all relations between the participants ("Who has to provide whom with which kind of information?").

Preconditions:

The first precondition of this concept is the definition and implementation of a standardized process for the exchange of information or between services in form of standards or regulations (ideally worldwide). These standardized processes must include all kinds of service levels and need to be accepted by all participating parties and service providers. The process has to be implemented as a software tool offered by the specialized software providers.

Advantages / incentives:

No system requirements and no expenditures of existing systems, services and tools are required due to the specification of a standardized process for information and services exchange to be compiled. The process describes the kind of information that should be offered to the next participant in the transport or information chain, respectively. Every participating entity has to provide the specified information based on their own or special software tools that support the standard process. Even small companies can use the standardized process by procuring a software tool providing basic functions. The standard process uses only one data protocol and ensures a high information quality without possible mistakes by manual input of operators during the parsing and translation process. Existing services and processes can be used while keeping all personal relationships (preferences and agreements) active.

Disadvantages / barriers:

The information quality depends on the quality of the previous service provider in the transport chain. The complete system follows an inflexible process and changes regarding the adaption of transport chains requiring a complex amendment process to the standards.

Participation in linking services:
This concept is designed to support the exchange of information of customers to track and trace their shipments (estimated time of arrival, information regarding to deviations along a supply chain, etc.), not the sharing of services. A possible participation in a linking service can only be occurred by implementing a standardized interface by every participant of its own. Therefore, the process-oriented organization of information exchange offers no additional benefit because all other modes of exchange (services, transactions, etc.) must be run by each participating party further on.

3.5. Conclusion:

Concept 3 as a system-oriented organization of transport related information exchange provides the most promising potential to set up a common structure needed in linking services. It can use existing structures and internal services as well as service platforms available at the present. The expert interviews show that most of the involved companies are very interested in cooperation with other companies to increase their efficiency. These companies, with the exception of large companies, do not have the possibility of investing in new software solutions or services. The existing solutions and services could be easily made to fit for cooperation by foreseeing standardized interfaces with translating and parsing functions to provide pre-defined standardized dataset and exchange protocols. This approach can be implemented by using APIs according to the OpenAPI initiative that process the standardized datasets to be offered to any other tool, solution or services that also uses these interfaces (see chapter 4.3.2 professional business model).

In the long term, the processes for handling the planning and execution of transport processes would have to be standardized. However, this is very difficult to implement due to the characteristics of the logistics industry which operates its business via customer-oriented individual solutions and thus achieves the long-term loyalty of its customers. The companies surveyed fear that with the standardization of processes, their Unique-Selling-Propositions (USPs) will be lost or that these will not be reflected in linking services. These fears could be countered by the strategy of standardizing simple sub-processes, which can be linked in the form of simple services via higher-level linking services.

4. Possible set-up of linking services for freight transport

Based on results of chapter 3, the following chapter describes possible applications of linking services using a real transport chain. The first part gives details on the technical background of all relevant instances and actors that are needed to run a multimodal transport chain in the food sector. The next step exemplifies a possible solution or architecture of possible linking services and includes, in the last step, some considerations regarding possible business models behind these linking services. For data protection reasons, no company names, locations and transported product groups are used. The described transport chain represents a multimodal transport route that is processed daily on weekdays.

4.1. Example of a real multimodal transport chain

The transport chain under consideration (see Figure 4) starts at a raw material producer for the food industry ("Producer / Shipper 1"), where the required raw material is loaded into special containers and transported by road ("Forwarder 1") mainly on motorways ("Road operator 1") to a container terminal ("Terminal 1" with "Infra operator 1"). There, the containers are reloaded onto a shuttle train which transports them overnight by rail ("Rail operator 1" on the infrastructure of "Infra operator 2") to a second container terminal ("Terminal 2" of "Infra operator 2"). From there, after reloading the containers onto trucks ("Forwarder 2"), they are delivered by road ("Road operator 2") to the producer ("Producer / Shipper 2"). After cleaning, the empty special containers are returned to the raw material manufacturer by means of the described transport chain (truck - shuttle train - truck), where they are refilled.
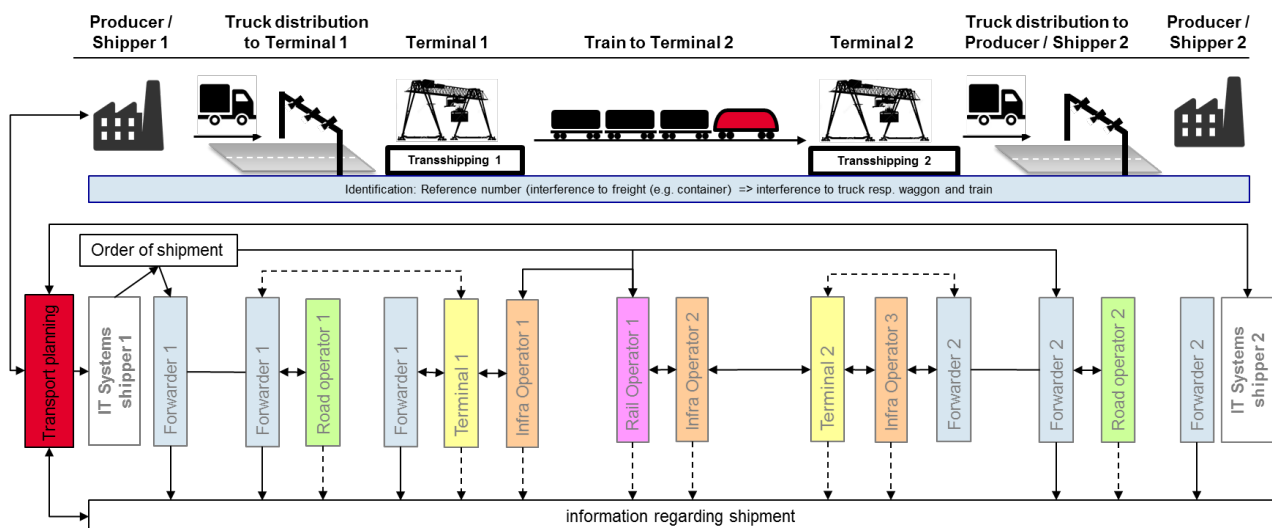

Figure 4: Example of a multimodal transport chain

Each instance involved in the transport chain described usually uses different software systems to plan and process the relevant part of the transport (see colored rectangles in Figure 4). Systems of subsections of the transport chain can also be handled with common solutions or services. In the case under consideration, this would be the handling in Terminal 1 and the transport of containers by rail to Terminal 2, whose infrastructures are operated by a large railway company. A similar situation exists in the case of Terminal 2, which is operated by the transport company that also delivers the containers to producer 2. In both examples, the software solutions are combined into a larger system and the data is exchanged with the other participants.

In this specific case, the individual subsystems could be combined via the standardized API as already described in chapter 0 and Figure 6 in chapter 4.3.2. This would also allow sensitive data and information (e.g. current positions of relevant trains, delays, deviations from regular operation, ETA rail, etc.), which are processed within the systems of the railway company for handling railway operations or on the road networks of motorway operators for toll collection (e.g., positions of trucks on the road network, ETA road, etc.), to be made available to external parties such as customers, operators of other transport infrastructures, freight forwarders, etc.). By implementing the authorization queries, data sovereignty is ensured in all cases. Through a higher-level linking service, the flow of information can be made more efficient so that the corresponding decisions can also be made in good time in the event of deviations.
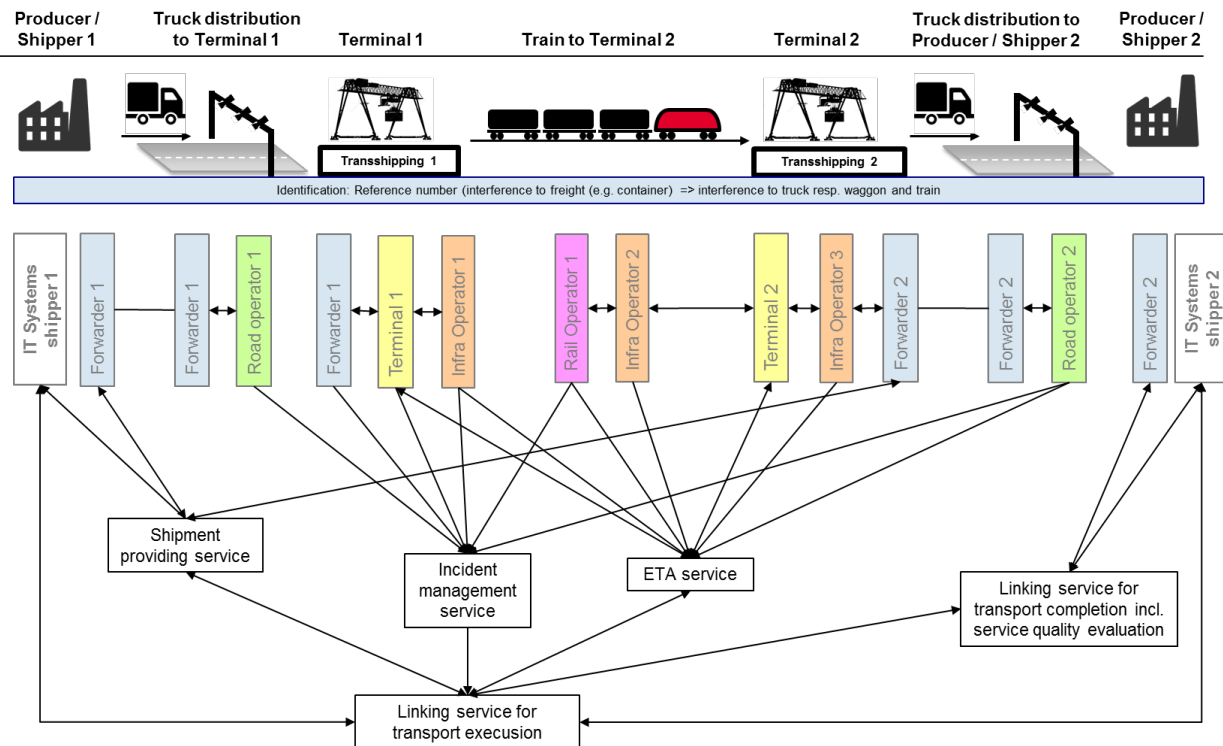

Figure 5: Linking services applied to the exemplary supply chain shown in Figure 4

Figure 5 shows a possible application of linking services based on the example of the transport chain described above. With the use of a central linking service ("Linking service for transport execution"), which plans and manages all necessary steps for the transport of the shipment from shipper 1 to shipper 2, these steps for planning and management are no longer necessary for shipper 1. Shipper 1 only has to inform the "linking service for transport execution" of the time and characteristics of the goods to be transported (weight, dimensions, type of goods, etc.). This accesses a "Shipment providing service", which transmits the corresponding available transport routes. Shipper 1 can select the appropriate transport route from a list (here forwarder 1) and announce it to the "linking service for transport execution", which initiates the appropriate steps. During transport, the information and tools of other services (ETA service, incident management, etc.) are used to provide shipper 1 with the required information on request.

After completion of the transport, a linking service "linking service for transport completion" is used to complete the transport process, which processes all insurance claims that may have occurred and carries out the settlement of the services. Furthermore, this linking service includes the evaluation of the service quality involved parties, which can influence their pricing and payment rates (see chapter 4.3.2). Shipper 1 has the advantage that it only has one contact point for handling a transport and does not have to be in contact with the necessary operators of the infrastructures and the means of transport.

When considering a possible architecture for the example, it would be advisable to combine the subsystems and services already used into higher-level partial services that represent specific planning and scheduling tasks, infrastructures and services (payment service, etc.). These could be, for example, a "Linking Service Infrastructure" that agrees on all relevant services for the operation and status of the infrastructures used. This means that these linking services can also be used for a variety of applications for the mobility of persons and goods.

4.2. Technical background to exemplify linking services

A transport chain can be divided into three different types of streams:

- Material flow representing the transported goods
- Information flow representing the stored data, such as transaction data, deviations and measures for problem solving
- Data flow representing concrete data for billing, complaints, etc. These ensure that the commercial processing from the order to the preparation of the freight documents is ensured. The responsibilities and obligations for transport processing are also stored here.

The following added values can be generated by setting up and using linking services:

- Added value for operations (material flow) is a better coordination via the transport hubs such as terminals, which is the interface between the modes of transport road and rail or ship, as well as terminal-internal processes. This is where all relevant information comes together and thus can be made available to all parties involved.
- Added value for information flow is the improved coordination and optimization of the transport chain and the resources required for it.
- Added value in data flow results from improved accounting accuracy, better perception of responsibilities and duties as well as improved traceability and documentation of all relevant processes.

Table 2: Matrix of services, stakeholder and flows (goods, information and data) as the mainframe of linking services

	Material flow	Information flow	Data flow	Customer 1	Customer 2	Customer 3	…	Operator 1	Operator 2	Operator 3	…
Material flow											
Information flow											
Data flow											
Customer 1											
Customer 2											
Customer 3											
…											
Operator 1											
Operator 2											
Operator 3											
….											

Linking services not only provides the ideal link and connection between the companies involved, but also the link between the three streams mentioned above. The streams always need data and information from the other two streams in their area.

Linking services provide the basis for automation not only of the transport process, but also for the transfer of information and data. This is the basis for implementation of the Physical Internet to revolutionize the transport of goods. In the context of linking services, not only individual services must be linked with each other, but also the involved players such as companies, customers and others.

Linking services only work if all relevant stakeholders participate. There is a matrix of links between the subcomponents, participants and services (see Table 1). In the initial phase, when many players are not yet involved, the "gaps" in the matrix must be filled by means of increased effort in data and information procurement via conventional means (telephone queries, e-mail incl. data entry by personnel, etc.), which, however, poses the threat of delays and potential standstills in the handling of freight transports.

In the transport industry, information and data are mostly used in historically grown structures (customer relationships, in-house developments, etc.). As a result, a very complex, inhomogeneous system landscape for data management has grown over the decades, which in most cases uses many interfaces and data protocols. Standardization of these interfaces and protocols would enable more efficient and secure data transfer and processing. This could not only create a basic prerequisite for linking services and information systems, but also raise the potential for increasing the effectiveness and quality of the handling of multimodal transports.

The transport industry, and also the associated industry of system providers, is aware of this situation. For this reason, initiatives for simplification and standardization have been launched in recent years. The most promising of these is the OpenAPI initiative[1]. OpenAPI stands for Open Application Programming Interface. OpenAPI has developed architectures for data interfaces that define a uniform interface definition using REST protocols[2]. REST protocol was originally developed for easy use and uniform data exchange in applications for websites build on http-based web applications. This means that any software application, planning tool or similar software can offer a uniformly defined and quality-assured interface to the outside world using an intermediate application (OpenAPI).

Using this interface definition also ensures that the information, data and values offered at the interfaces really correspond to the defined parameters. In the past, a wrongly defined parameter by an incorrectly defined protocol when querying other systems (e.g. swapping contract numbers with wagon numbers, etc.) was a frequent problem. This is prevented by the exact and quality-supported definition within OpenAPI. Furthermore, the OpenAPI specifications provide software solutions that control the allocation and the definition of access rights to certain parts of the data offered in the interfaces (e.g. one company can access the data record regarding the above-mentioned uniform reference number, but no further information for the onward transport of the freight by another company). This ensures data sovereignty that is always required in the transport industry.

With the interfaces described, the approach of linking services could be used as a basis for a uniform exchange of information while at the same time ensuring the data sovereignty of the parties involved. The migration of such uniform interfaces for linking existing services based on various software solutions and tools would be driven forward quickly, since many major system software providers already offer OpenAPI interfaces as add-ons in their solutions or are currently developing them.

As an example, for the application of the described approach for linking existing and established systems and solution landscapes, the linking of various services is shown in Figure 6. The companies 1 to x represent different companies from the most different branches, which are involved in transport chains.
For the processing of a transport, for example, company 1, which does not yet have a cooperation partner for the processing, sets a request for a "Provider searching service" (PSS) for a suitable company for the execution of the needed transport using the company`s API (here API 1). The PSS in turn uses its own API (here API PSS) to access a "Supply and demand service" (SDS) and uses API 1 to refer the company 2 to x to carry out the service. All exchanged data sets are uniform and are in accordance with the OpenAPI specifications. The solid lines in Figure 6 represent the used communication channels. In our example company 3 gets the contract. If the companies already use a "supply and demand service", they can communicate directly via their interfaces (dotted lines). In this example, the transport service

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[1] OpenAPI Initiative https://www.openapis.org/

[2] REST - Representational State Transfer

is paid via a special "Payment Service 1" (PS 1), which also uses its own API (API PS 1) according to the OpenAPI specifications. The dashed lines show the corresponding payment information flows between company 1 and company 3.
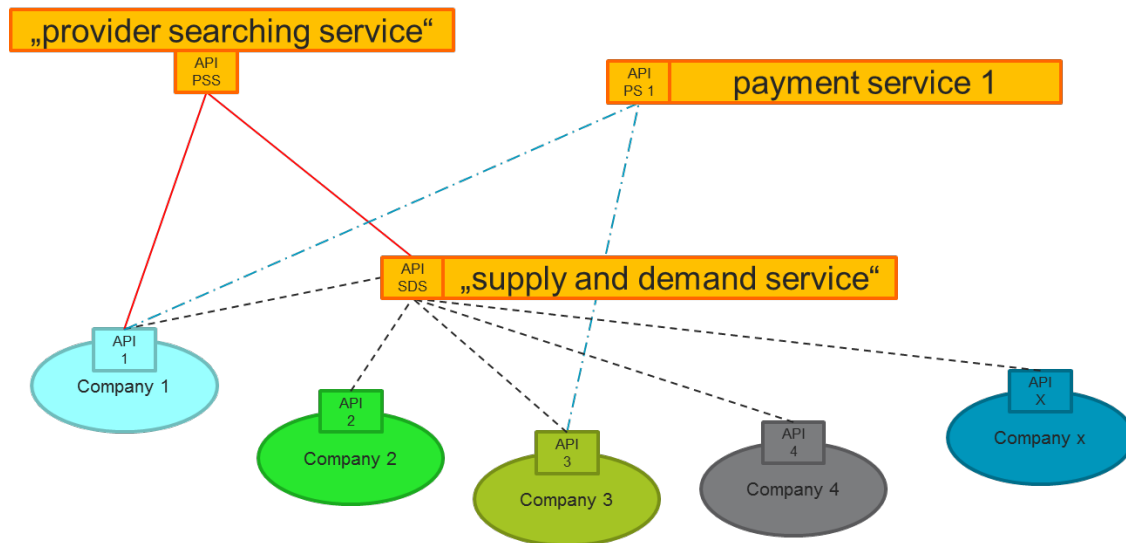

Figure 6: Example of a linked transport service

The linking services approach can only work if the data exchange and all necessary transactions included in the linked services run automatically in the background. Blockchain solutions can process these transactions securely and according to fixed rules which are implemented via software code in a smart contract represent all needed steps to fulfil a transport.

Excursion regarding to blockchain technology:

The applications of the blockchain technology started in the financial areas for the processing of secured settlements and the administration of funds, etc. The potential for users is that so-called intermediaries, who have to confirm or certify a transaction (notaries, banks, freight forwarders, etc.), would be eliminated, since in the (peer-to-peer) settlement in course of the cooperation between the individual companies is handled via clear and difficult to manipulate digital "contracts". This would considerably reduce or eliminate transaction costs and the costs of forwarding the associated documents (bills of lading, etc.), which are usually in paper form.

Each participant in a blockchain always has the same level of knowledge as the others due to the decentralized storage of the data. The basic idea behind the blockchain is that all activities along a logistics chain, for example, are divided into individual transactions. A block is a collection of individual transactions that are validated together. A transaction is only valid if the conditions associated with this transaction (as defined in a Smart Contract, for example) are fulfilled. A transaction is valid if the consensus mechanism for the one containing the transaction has been executed. Apportioned to a transport or logistic process, this would mean that a payment for a shipment would only be triggered once all previously defined conditions have been fulfilled (for example, payment only if the agreed temperature band for a reefer container has been met).

A blockchain uses a distributed ledger in which all relevant rules for processing a chain of sub steps are stored as software code. A distributed ledger, also known as a common ledger, is a technology that enables a group of participants that "do not trust each other" to perform a common, recognized transaction history (transactions are entries in the ledger). Blockchains are a specific subclass of distributed ledgers that ensure the integrity of the transaction flow through a chain of hashed and linked transactions (or blocks).

A blockchain is a digital list of transactions between all accounts in a chain, which stores the associated information decentral on many computers. Thus, it would take an immense effort to manipulate the information of a blockchain. With this "security system" in the background, the blockchain technology would be particularly suitable for handling transport processes (goods or passenger). Once a blockchain is completed, it is difficult to manipulate or verify which would create an important basis of trust. A further effect on the current system in the transport industry or in transport and traffic would

be the elimination or the significant reduction of "fears" regarding the sharing of information and could thus enable the required cooperation between those involved in the transport chains.

Smart Contracts are digital contracts in the form of software that continuously check the subjects and conditions of the contract and their compliance. This would mean that checking or confirming intermediate functions (intermediaries), such as banks, notaries, etc., would no longer be necessary for drawing up and checking contracts. So-called smart contracts are computer-controlled transaction protocols that execute contract conditions securely and autonomously as software. For example, when a container ship arrives in a port, the necessary actors are automatically assigned to unload the ship and load it onto the other modes of transport through processes defined in the Smart Contracts.

Like any other (software) program, the blockchain can be implemented both locally and as a web application. These variants are indistinguishable at first glance since the interactions with memory and transaction layer are decoupled from the user interface. However, they have two different characteristics: 1) a user is not identified by a user name, but by an anonymous address protected by a password or encryption key; 2) interactions with a blockchain are asynchronous, since the validation of transactions can take from a few seconds to hours depending on the type of blockchain or other factors. Therefore, an immediate confirmation of an action in a blockchain application cannot be expected.

The advantage of using contracts often referred to as "self-executing" transactions within the blockchain would not only relieve the accounting systems, but also create transparency for all parties involved. In addition, blockchain-enabled transactions would generate further advantages for the transport industry:

- Use of "Smart Contracts" for ad-hoc transport (cooperation in the efficient transport of goods)
- Use of loading space by several companies
- Immediate payment upon delivery
- Self-managing fuel and maintenance payments
- Fully automatic billing
- Unlimited progress and safety recordings

A possible implementation of linking services with the help of blockchains could be designed in such a way that the individual services required for a solution or processing a chain of actions (see Figure 2) are stored and regulated in a "smart contract" tagged with a unique identification or reference number. All processes for the necessary interaction of the sub-components of transport processes are mapped in a structured manner and equipped with the necessary regulations. The necessary monetary transactions and the access rights of the individual applications (OpenAPI approach) are stored for the interaction of the different services. The linked services can be unwound automatically without manual intervention and are fully documented by the blockchain technology and secured against subsequent manipulation.

This means that a uniform reference number for the individual shipments, which is often required by the transport industry, can also be generated and managed. Due to this, the actual transport is completely traceable, but also its documentation from order creation to delivery (status of freight, transactions, insurance services, etc.) is permanently accessible.

The new approach of linking OpenAPI approaches and integrating the available data and information in a blockchain is currently still relatively unexplored or is associated with a deep skepticism among decision-makers in the field of mobility. Blockchains are currently being researched in almost every industry branch, including insurance, healthcare, banking and finance, transport and logistics, manufacturing, energy and creative sectors. However, it should be borne in mind that implementations of Smart Contracts are not yet mature. The major software and consulting companies, such as SAP, IBM, Qualcomm, Ernest&Young, etc. have set up their own departments (Blockchain Labs) in recent years, in which future applications are investigated and the appropriate tools for creating and processing blockchains are developed tailor-made for the market and industrial sectors. "Blockchain in Trucking Alliance (BiTA)" (https://bita.studio) is a broad consortium of vehicle and transportation companies (organizations such as McLeod Software, Triumph Business Capital, U.S. Xpress, Convoy, 10-4 Systems, Fleet Complete, TransRisk, etc.) founded in August 2017 to establish blockchain technology in **fleet management and freight forwarding**. Within the scope of the activities, standardized processes and protocols will be defined and should simplify the use of the technology in the future.

4.3. Specific business models for linking services

This chapter delivers two examples of business models in the context of linking services. Both models use a system-oriented organization of information and service exchange (see concept 3 in chapter 3.3). Once more, a "light" version is assumed for simplified implementation in the start-up phase, expanded to a "professional" approach by integrating additional functions (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). The development of both business models is based on results of the research project "TRIUMPH II – Trimodaler Umschlagplatz Hafen" [TRIUMPH II2016] and the findings of the study "Rail & Road Traffic Management" [ÖVG2016] as well as the conclusion of the workshop with management software providers.

The "light" version of a concept is assumed for simplified implementation in the start-up phase. This concept uses billing of initial costs, a running basic fee and a fee per click in the platform. In the next step, it will be expanded to a "professional" approach by integrating additional functions and more dynamic and detailed data and information sources (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). In fact, both business models can be deployed simultaneously so that all participants can benefit from the specific strengths of both approaches.

Table 3: Comparison of two concepts to exemplify linking services

	light	professional
Database	Transport infrastructure and intermodal nodes • offered relations (line operation) and time tables • tariffs per km, tariff zones, graduated conditions • standard prices for standard products • hub costs incl. graduated price • terminal operation times	Transport infrastructure and intermodal nodes • currently offered relations (line operation) and time tables • tariffs per km, tariff zones, dynamic special offers (prices according to utilization of cargo space / terminal) • standard prices for standard products • hub costs incl. addition / discount • terminal operation times
Functionality	Provision of information • Multimodal routing incl. comparison of price, emissions and runtime • Forwarding to involved enterprises • M2M interface for requests from IT services to IT service provider and proprietary API or HMI interface to participating company	Provision of information – booking – billing • "Near real-time" multimodal routing incl. comparison of price, emissions, runtime and currently available capacities • M2M interface for requests from IT services end-to-end • Booking and paying of complete transport service with all involved companies
Level of integration	Static data, planned data	Dynamic data, real current data
Interface to customer and linking services	Web based GUI (browser or mobile app), proprietary API interface customized to existing IT-system environment provided by IT service provider, which also provides M2M OpenAPI interface for all participating transport-related linking services	B2B interface with standardized interface (e.g. REST protocol): • translating enterprise data for standardized data requests • booking and payment transactions via M2M interface • data sovereignty by defining access rights
Price model	Basic fee + transaction-related fee	Dynamic fee: requests-oriented / compensation for data / service providing no costs arise for IT service provider (not required)
User group	Open network	Restricted group of users incl. background check

4.3.1. Business model „light"

According to the "light" concept of a linking service architecture (see Figure 7), IT service providers are operating data and service platforms (hubs) in front of companies as an operational digital representative (proxy). The hub's IT systems are connected via web GUIs, e-mail and mobile apps to the employees (dashed lines in Figure 7) and via proprietary interfaces customized to the existing service environment of their clients (permanent online connection, see solid lines in Figure 7). On the other hand, they provide standardized data and service access to all participating linking services via OpenAPI using predefined protocols (REST data formats). For example, an extended multimodal routing service for goods can request transport-related data via standardized M2M interfaces without being connected bidirectionally and online with the transport service provider. Nevertheless, the service can provide a comparison of target prices (tariffs), emissions, timetables and transit times of the offered routes, business hours of terminals and freight hubs or production sites. Also, companies which are connected via OpenAPI directly can communicate with them via such hubs.

To provide additionally booking and payment services in the business model "light", the well-known and frequently used "booking.com" service may serve as an example. The aforementioned service provider (hub) can reserve a contingent of transport and transshipment services to special conditions. The company can store "meta data" on offered relations (line operation) and time tables, tariffs per km, tariff zones, etc. via web browser interface. The hub can offer booking and payment services provided with the role of distribution intermediaries on a commission basis. Incoming bookings of cargo are communicated via proprietary APIs or email to the transport service provider.

The pricing model of this linking service-enabling data and service platform consists of different aspects. First one-time initial costs, second a current basic fee (scaled according to purchasing volume) and third ongoing costs depend on the number of communication transactions. This easy to implement way to get access to the world of emerging linking services should be an "appetizer" for interested companies, authorities and stakeholders using existing services and solution without the need of large investments. The participation in such a framework would show the advantages of providing data and information to other involved companies. Based on the experiences and advantages of the users of the light version, firstly an opinion-forming process could be initiated. This could inspire potential future users to participate in linking services and, as a logical consequence, build up a "professional" model's direct access point via own OpenAPI M2M interfaces without the use of an IT service provider.
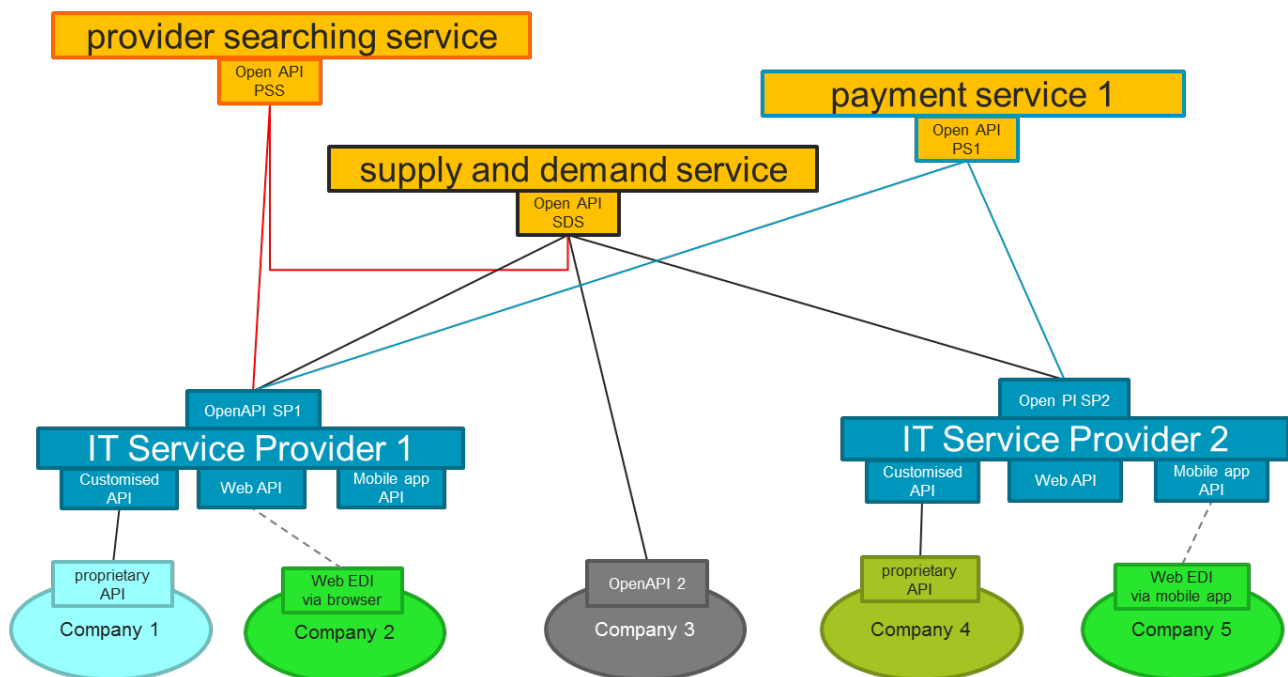

Figure 7: Architecture of business model "light"

4.3.2. Business model „professional"

The "professional" business model (see also Figure 8) is designed for a broad application of linking services with a view to provide the basis for the functions required in the future as part of the "Physical Internet". It has a higher functional depth than the business model "light" described in chapter 4.3.1. It is based on the requirements according to a system-oriented structure (see concept 3 in chapter 3.3). The business model uses a standardized API-architecture according to the OpenAPI concept (see chapter 4.2 and Figure 6) based on REST protocols and a permanent online connection between all involved participants (solid lines in Figure 8).

Linking services only work if many users use them or make corresponding data and services available for linking. There are some variants to ensure an appropriate number of attending partners in linking services:

- Very large companies with their own proprietary software solutions implement a standardized API to their own software solutions to enable a bi-directional exchange of data and the usage of their internal services by external services or companies (third parties). The function of the OpenAPI includes the necessary access authorization processes to ensure data sovereignty and security.
- Companies with a widely-used software package for transport planning and management offered by system software providers (SAP, IBM, etc.) use OpenAPI solutions fitting to their software solutions.
- Linking service platforms as described in the business model "light" (see chapter) offer the connection to linking services for small companies that are not able to implement an OpenAPI of their own.

The OpenAPIs enable bidirectional translation and parsing of company data, ensuring data sovereignty through the definition of access options and the provision of uniform data. This ensures that the individual values of the generated data records always correspond globally to the defined properties. The development and technical implementation of this broad approach to enable linking services requires enormous organizational and economic effort on the part of the organizations and companies involved. This cannot only be borne by the companies involved but must be supported by appropriate subsidies (authorities, etc.) and migration strategies.

The "professional" business model must offer and support all functions to automatically perform all relevant processes, such as the actual linking processes and the associated service charging processes. This is the only way to enable the necessary functions for implementing the "Physical Internet".

For the operation of linking services, the infrastructure costs for the platform (server costs, maintenance, etc.) and the monetary equivalent of the data or services to be linked must be considered on the cost side. Operating costs should be addressed through a user fee for participation in a linking service. When setting prices, attention should be paid to the lowest possible entry threshold to ensure non-discriminatory access for all interested parties. The intensity of use and, above all, the intensity of the provision of information and services by each party must be considered.

The pricing model should be based on dynamic fees in accordance with the number of requests of each entity using a lining service. The fees of each linked party (companies/users or services), will be compensated with dynamic fees payed by the linking service for providing information or services. For monetary processing, an architecture based on the properties of the user/API and integrated in the blockchain in the form of tokens should be considered. The definition of a token within the blockchain is the digital representation of a real equivalent, such as a property, the copyrights of a work, etc. The token also represents the equivalent of the quality of the data provided, with which a "user/API" can be evaluated. The use of linking services can be charged according to the frequency, importance and quality of the provided data records or services of each involved OpenAPI (token). Owners of tokens, who often provide high-quality data of importance for the processing of the linking services, would pay less.

With this approach, smaller companies could also be quickly integrated into the system landscape of linking services, even if they do not use their own services. These companies can purchase cost-effective APIs that offer basic functions for integration into linking services. These low-cost APIs with basic functions were to be made available by a group of major system software providers. This ensures that even small companies have easy access to this technology of the future.

No intermediate data and service hub is required because all participating companies have directly connected APIs to linking services. Therefore, there will be no further expenses. On the other hand, IT measures on IT security and the API license costs occur. Mechanism like "block chain technology" can ensure data security and data protection. Data sovereignty always remains in the hands of the owner.
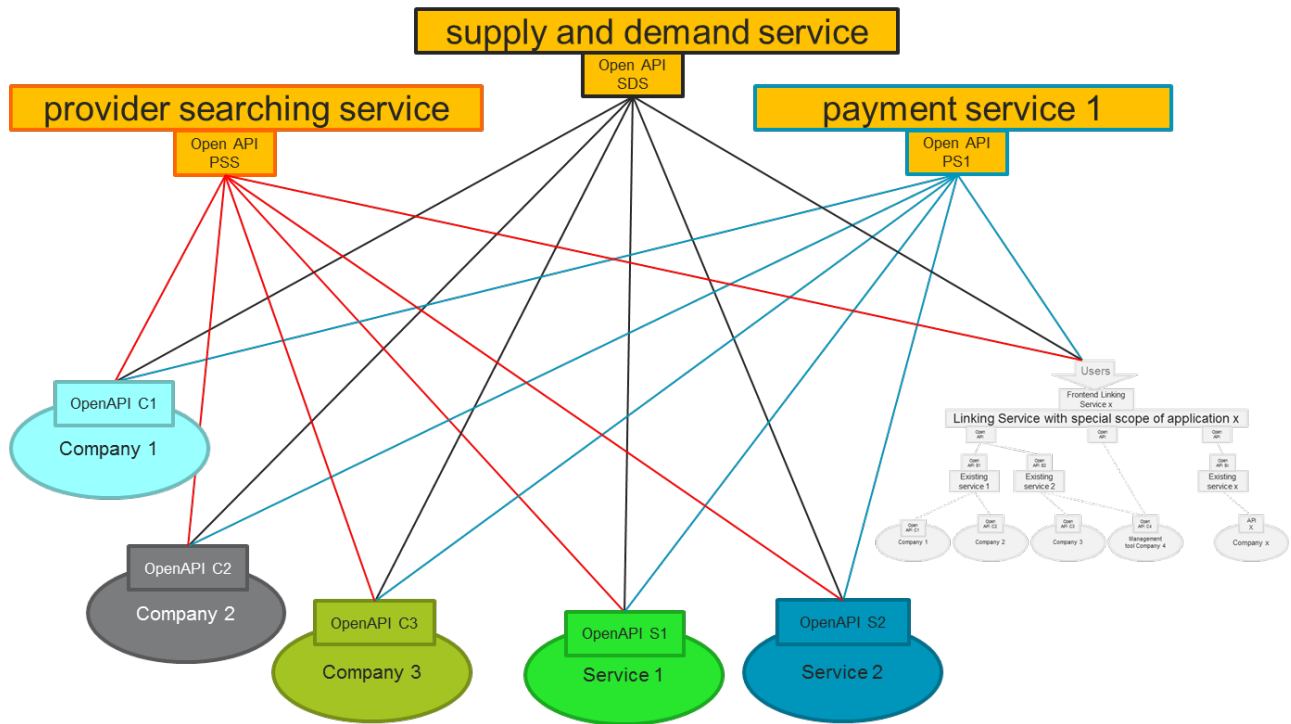
Figure 8: Architecture of business model "professional"

5. Conclusion

The structures for handling mobility and transport processes are based on organizational and technical structures that have evolved over time. Companies and participating organizations have developed tools to support the efficient handling of mobility needs. These services are usually tailored to the needs of the participants or were developed by themselves and represent isolated proprietary solutions. By linking these individual solutions or the individual services offered on the market, it would be possible to simplify the handling of transport processes. This can lead to an increase in efficiency in the transport sector. Furthermore, the basis for the digitization of transports and the establishment of the innovative concept of the "Physical Internet" will be created.

The study "Linking services for mobility of goods" aims to assess the current conditions in mobility of goods and, based on this, to clarify the related research questions.

5.1. Results of the expert interviews

The following chapters 5.1.1 to 5.1.4 conclude the findings of the expert interviews.

5.1.1. What are the barriers to access data and information in the transport industry and logistics?

Barriers to access data and information in the transport industry and logistics

- Full service providers would open resp. provide their own network to competitors without profiting from it
- Fear of industrial espionage and loss of the Unique-Selling-Proposition (USP)
- Legal concerns: different handling of antitrust law, competition law, General Data Protection Regulation (GDPR) / data protection
- Unstable Internet access: access times, availabilities
- Poor data quality and incompatibilities with low interoperability
- Transport services are usually very individual and therefore cannot be standardized
- Uniform data connection / maintenance -> high work and cost expenditure + low willingness to invest
- Difficult safeguarding of IT security and data sovereignty
- Dependence on IT specialists, high investments in IT systems and no IT capacities at companies

5.1.2. Which potentials are recognized by "linking" different services in the field of mobility of goods?

Potentials through the "linking" of services in the field of mobility of goods and where to expect them

- Additional information channel (primarily shipper) + procurement/distribution channel (primarily forwarding agent)
- Simplification of processes and better planning in advance through standardization
- Greater transparency of the supply chain, with better price comparability
- Digitization of the forwarding model leads to a reduction in complexity
- Reduction of production costs through better integration of production and transport
- Dynamic pricing can smooth out order peaks (e.g. terminal turnover)
- Regulatory intervention via routing service is possible (Brenner route can only be enabled for railway mode, etc.)
- Possibility of standardized multidimensional (traffic mode) decisions when awarding transport contracts
- Areas of mobility of goods with the greatest potential:
  - SME forwarding sector (without complete system and less IT maturity)

- o Introduction step-by-step first unimodal then with terminal, then with pre / post processing
- o simple standard transports without manual interaction, no dangerous goods, no deadline accuracy

5.1.3. Which non-regulatory incentives could improve access to data and information in the transport industry and logistics?

Non-regulative incentives to improve access to data and information in the transport industry / logistics

- Economic benefit / additional business through linking services (for both sides)
- Reduction of production costs:
  - o Cost reduction/savings and efficiency increase through standardization
  - o Synergy effects (saving of resources)

5.1.4. Under what circumstances are data holders and service providers in the field of mobility of goods prepared to make their inputs available to third parties?

General conditions for readiness to make data and information available to third parties:

- Only basic information, such as offered routes, timetables, standard prices, handling costs
- Third parties should be potential customers
- Legal clarification of the binding nature of the offer and availability of the services
- Ensuring IT security, data protection and sovereignty, IT competence and standardized protocols
- Verifiable framework agreement on liability issues, insurance, approvals and concessions
- Appropriate international legal requirement for infrastructure managers
- Continuous reference number (blockchain) -> position/status of shipments
- Mutual data exchange (bidirectional)

5.1.5. Strengths and weaknesses of linking services

Strengths of linking services

- Continuous flow of information, transparency of information
- Premature provision of data for planning work steps and processes
- Dynamic pricing -> Market transparency and strong advantage for customers
- With linking services quick intervention via regulations in the algorithm in traffic control
- Easier transport optimization and planning according to price, environmental impact, etc.
- Stronger integration of processes (production>work preparation>logistics and distribution)
- Synergies increase efficiency and reduce cost pressure
- Eliminate input and decision errors (the human factor)
- Standard OpenAPI enables automation and forms the basis for "Physical Internet".
- Software makes more rational decisions to solve problems

Weaknesses of linking services

- Risk of formation of a hard monopoly
- Many open questions regarding liability conditions, willingness to cooperate, etc.
- Data protection strategy that is difficult to assess (GDPR new) including the resulting restrictions
- No available standards
- Acceptance of a central point for linking services
- The timeliness of service data (reaction time, situation, synergisms, etc.) is difficult to assess.
- Special cases difficult to map (sensitive goods, stackable or not, etc.)

- High IT affinity of companies for linking services required
- Interfaces are vulnerable (IT security)
- Elimination of the forwarding business (as we know it today)

5.2. How could concrete business models in the cooperative use of data and information look like? Are there examples from other industries where this has already been successfully implemented?

Using an exemplary multimodal transport chain, the findings from the interviews were examined in two possible technical and organizational implementation concepts. These are coordinated in such a way that they build on each other in chronological order.

The business model **"light"** of a linking service platform is basically structured like an extended multimodal router with a connected bidirectional information platform using OpenAPI interfaces to communicate with services and data platforms. It contains the comparison of target prices (tariffs), emissions, timetables and transit times of the offered routes. The platform is designed for free use via a web browser and links services of transport infrastructure data and handling nodes as well as data of transport and handling companies or forwarders. The price display and billing of the use of this linking service platform is carried out via one-time initial costs, a current basic fee or a settlement via the number of accesses ("pay per click").

Applying the business model "light" approach, smaller companies could also be quickly integrated into the system landscape of linking services, even if they do not use their own services. These companies can purchase cost-effective APIs that offer basic functions for integration into linking services. These low-cost APIs with basic functions were to be made available by a group of major system software provider. This ensures that even small companies have easy access to this technology of the future.

The business model known as **"professional"** is the technical successor of the "light" concept and uses standardized API (Application Programming Interface) according to the OpenAPI initiative for information exchange e.g. via REST protocols (Representational State Transfer). Users are free to choose between using their own OpenAPI interfaces based on their services or using API solutions from software providers. The OpenAPI interfaces offer standardized data sets at uniformly defined interfaces, which makes it possible to link the services with various technical architectures and data protocols. The API has the task of retrieving company data and transport-relevant information from the company's own systems, translating it into the uniform REST protocols and regulating bidirectional access rights. This enables the cost-saving provision of uniform data that can be used world-wide and the benefit of existing services and solutions can continue to be used.

The "professional" business model for a linking service is to be offset by implementing blockchain approaches using tokens that represent the equivalent of the quality and importance of the data supplied for the processing of transport processes. Owners of tokens would pay less, which often provide high-quality data of importance for the processing of the linking services.

Experts indicated that potential users of linking services are quite unfamiliar with the term "linking service". Many people generally associate the term with the linking of data and information on the status of available infrastructure and transport processes. Therefore, experts stated that also awareness building is an important issue. Moreover, future implementations of linking services must use the same standards / protocols worldwide to offer central coordination of decentralized services. Reference implementations could provide a basis for virtual freight forwarder services and support awareness building.

Linking services could improve data quality and seamless information exchange among different process actors. The necessary digitization of companies is already taking place in the large companies in the transport and production sector and is seen as an opportunity to counteract the enormous cost pressure. Linking services could support transforming monomodal solutions to multimodal solutions. Doing so, the response to malfunctions and switching between transport modes may be supported efficiently. With the proposed architecture of linking services, existing resentments against the passing on of information and data to third parties could be eliminated and thus the experience of the sparse use of currently available freight exchanges could be counteracted.

Furthermore, experts indicated concerns that inking services could partially dissolve existing distribution channels, and that existing niches (tailor-made solutions for certain companies or products) in the transport sector could either disappear through linking services or be hard to realize. Experts also raised concerns of freight forwarding companies, since linking services for automated planning and executing of transport processes could significantly impact their business model.

The experts also stated that there is a danger of monopolies being formed, as linking services are a balancing act in antitrust and competition law. To this end, it must also be clarified which organizational form is chosen to operate a platform for linking services and how these platforms can be checked. The framework conditions must be chosen in such a way that access hurdles (high usage fees, technical requirements, etc.) prevent the formation of communities that exclude groups of companies. The different IT maturity of the companies must not represent an access barrier either.

The architecture of linking service platforms must focus on data protection so that no conclusions can be drawn upon the business conduct of users. To counter these critical points, well planned information campaigns regarding the essential functions of a linking service platform must accompany the planning and implementation.

5.3. Recommendations for actions

Linking services provide the basis for automating not only transport processes, but also for seamless information and data exchange. This represents the starting point for implementing the "Physical Internet" to revolutionize the transport of goods. Especially, with respect to "interconnected logistics Systems" (cf. EU Alice ETP). In the context of linking services, not only individual services must be linked with each other, but also with the involved players such as companies, customers and others.

The services and platforms offered for the transportation branch (transport of passenger as well as goods) today represent a wide range of data, information, functions and services developed for specific customer requirements or to optimize processes of the involved companies. As a whole, they are more or less isolated solutions. Linking services have the potential to connect all these data and information sources and services via standardized interfaces like developed by the OpenAPI initiative. The interface definition does not only provide a so-called parser function for translating data formats and protocols, but also standardized checks of access authorizations to data and partial services or software libraries contained in the services to be linked.

5.3.1. Recommended actions on international level

Due to the high investment required for the digitization of companies, the implementation of linking services can only take place via suitable internationally agreed support measures. This process has to be accompanied by a structured and internationally coordinated information and opinion-forming process. All activities to bring linking services to the market must be organized and managed by a superordinate association gathering all relevant stakeholders (potential users of linking services, national and international authorities, other associations for standardization, etc.). As a first step as a course of action for an opinion building process has to be set-up on international level. Organizations like the FIATA (Fédération Internationale des Associations de Transitaires et Assimilés), the World Shipping Council (maritime transport), UIC (rail freight and rail operations) or the IRU World Road Transport Organization (road transport) to provide a set of recommended actions to be followed and executed on national level.

The cooperation with international standardization associations like GS1 who developed the standards for the definition of the unique container identification numbers and standards regarding barcodes and QR-codes or TISA working on standardization of information exchange in the passenger transport, will help to benefit from synergies with existing standards. This would enable the merging of existing standards with the preparatory work of the OpenAPI initiative for standardized information and data exchange. This could be used to develop a uniform standard for the transport system that could cover all areas in the future.

With the formation of an international association focusing on the activities to promote linking services it will be possible to establish a contact point where all needed actions could be coordinated and all interested groups, national organizations, etc. could be provided with all relevant information. Another important task of the association would be to identify potential problems in the introduction of linking services and to develop strategies to counteract them. The focus will be on the development of migration strategies. The question must be clarified whether the market launch should take place "step-by-step" or with a rather unlikely "big bang". The "step-by-step" strategy would have the advantage that existing software tools and services could be successively expanded and made productive with the necessary functions.

A main strategy of the awareness and opinion building process could be to communicate the linking services will not wipe out the field of activity of freight forwarders as many stakeholders are afraid of. Freight forwarders will use linking services to offer special customized services to their existing and future customers. This is comparable to the situation of travel agencies in passenger traffic, whose continued existence was also discussed after the market entry of travel booking platforms such as Trivago® or booking.com®. The travel agencies still exist today and have specialized in the planning of special travel offers. The communication strategies and the needed process of opinion making should highlight the example of the travel agencies to argue against the prognoses of possible losses of branches in the transport sector or employment due to rolling out linking services for the mobility of goods.

Due to the high investment requirement for the digitization of companies, the implementation of linking services can only take place via suitable internationally agreed support measures. This process must be accompanied by a structured and internationally coordinated information and opinion-forming process.

To carry out this process in a coordinated manner, an association with a worldwide scope is recommended. The task of the association should concentrate on the following points:

- Clear definition of the standards to be used
- Coordination and use of synergies with existing standardization organizations from the transport sector (GS1 for freight transport (container numbers, barcode, QR code) or TISA for passenger transport)
- Promoting cost-effective software packages for smaller companies that are jointly developed by large software providers and offer basic functions for handling transports and connecting to linking services via the standardized OpenAPI interfaces.
- Development of strategies for monitoring of future linking services in the areas of compliance with the legal framework, non-discriminatory access for all interested parties, correct economic processing of transactions, etc.

5.3.2. Recommended actions on national level

Based on the experiences made with linking services in public transport an opinion building process should be started on national level by special interest groups of the related branches in the transport sector and all corresponding branches. These special interest groups resp. associations like Chambers of Economics, associations of the transport, service and software branches, as well as the national Chambers of Labor should address their members to participate in a broad defined stakeholder process supported by the responsible ministries. This process should ideally include an intense world-wide exchange of information regarding the status of the national stakeholder processes and the planned actions with all other national initiatives.

5.3.3. Further activities:

However, there is still a great need for research into the implementation of the linking service platform described here, especially using blockchain technology. The topic of integrating blockchain technology in the future linking services has a high demand on research work to define the best fitting concept to be used in linking services. Blockchain technology has the potential to be used for data access control and seamless documentation of all transactions along the transport chain. The major system software providers already offer the first tools for the use of blockchain technology in certain sectors, such as insurance companies, banks, energy industry and for individual applications in the mobility sector. However, cost-effective solutions must be created to remove the barriers to access identified for small businesses.

For the implementation of a Linking Service Platform, especially using Blockchain technology, there is still a great need for research. Large system providers are already offering the first tools for the use of blockchain technology in certain industries, such as insurance, banking, energy and for individual applications in the mobility sector. However, cost-effective solutions need to be created to remove the identified barriers to entry for small businesses.

To simplify the integration of software in future linking services, recommendations should be developed for the architectures of future software products (services for special applications within and outside the transport sector). The software architecture should support a system-oriented organization of the exchange of information and access to internal services and already provide corresponding interfaces (OpenAPIs) or their subsequent implementation.

Moreover, the authors consider the subsequent action items as supportive for implementing linking services:

- Alignment and definition of linking services across logistics actors and technology providers
  - service standardization (GS1, IT provider, logistics provider)
  - building platforms for knowledge exchange related to linking services (best practices, do's & don'ts, tech. support)
  - identification of early adopters and driving forces for implementing linking services (e.g. Industry player as early adopter, active standardization members, etc.)
- Evangelizing Linking Service concept
  - e.g. within Physical Internet Community (EU Level Alice ETP)
- Strategy development related to the implementation of linking services
  - How could monopoly building be avoided?
- Enabling secure data exchange and trust between linking service partners
  - Collaboration with early adopters of Blockchain technologies in the transport sector and knowledge exchange (e.g. Blockchain in Transport Alliance - https://bita.studio/)

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7. Terms, definitions and abbreviations

BiTA   Blockchain in Trucking Alliance (https://bita.studio)

Blockchain   A blockchain is a digital record of transactions. The name comes from its structure, in which individual records, called blocks, are linked together in single list, called a chain. Blockchains are used for recording transactions made with cryptocurrencies, such as Bitcoin, and have many other applications. Each transaction added to a blockchain is validated by multiple computers on the Internet. These systems, which are configured to monitor specific types of blockchain transactions, form a peer-to-peer network. They work together to ensure each transaction is valid before it is added to the blockchain. This decentralized network of computers ensures a single system cannot add invalid blocks to the chain.
When a new block is added to a blockchain, it is linked to the previous block using a cryptographic hash generated from the contents of the previous block. This ensures the chain is never broken and that each block is permanently recorded. It is also intentionally difficult to alter past transactions in blockchain since all the subsequent blocks must be altered first.
(source: https://techterms.com/definition/blockchain , accessed on 27 Jun 2018)

CRM   Customer Relationship Management

GDPR   General Data Protection Regulation (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2016:119:TOC)

ETA   Expected Time of Arrival

FTL   Full truckload

Linking Services Is a new approach in the context of transport chains. Linking services supports the communication between companies in industry, producing companies, logistics and transport service providers and commerce via standardized application programming interfaces (API).

LTL   Less than truckload

OpenAPI   Initiative of software providers and companies to standardize data and information exchange of solutions with different technical set up using standardized protocols based on REST-protocols (https://www.openapis.org)

Physical Internet Physical Internet is a concept for an optimized, standardized global freight transport system based on the idea of the digital Internet. Contrary to today's approach, in which a single transport service provider transports goods over long distances, the idea of the Physical Internet relies on fragmented, vendor-independent transports. (source: https://logistikknowhow.com/physical-internet/, accessed on 27 Jun 2018).
The goal of the concept "Physical Internet" is to organize freight shipments in normed modular containers, which are moved from the sender to the recipient on an autonomous, intermodal path with minimal costs and in an environmentally and socially sound manner.

RCA/RCG   Rail Cargo Group Austria AG

REST-protocols REST - Representational State Transfer pre-defined protocols to exchange and manage standardized and quality assured data sets

SME   Small and medium enterprises

WLC   Wiener Lokalbahnen Cargo