A platform for secure, safe, and sustainable logistics

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Abstract. In the current society, logistics is faced with at least two big challenges. The first challenge considers safety and security measurements dealing with terrorism, smuggling, and related security accidents with a high societal impact. The second challenge is to meet sustainability requirements implying optimal use of resources and physical infrastructure. A condition sine qua non for dealing with these challenges is the realization of a flexible platform for sustainable and secure data exchange between collaborating global supply chain actors. This paper presents such a platform. It allows shippers, authorities, logistic service providers, and carriers to be fully interoperable across closed communities, to perform paperless logistics, and to adhere to societal demands of security, safety, and sustainability. Its functionality is derived from similar approaches as have been applied in modern social media. The paper elaborates on the functionality of the platform and its implications for research. It builds upon the research and innovation work as currently done within the EU FP7 Cassandra and iCargo projects.

Keywords: security, sustainability, paperless logistics, interoperability, communities, platform

1. Introduction

Current societal demands to business and authorities can be described as sustainability, food safety, and security. Corporate Social Responsibility (CSR) encompasses these demands and is considered to be an interface between business and society (Brammer, Jackson, & Matten, 2012). The European Union considers these demands as part of its 2020 Strategy by not only increasing energy efficiency and decarbonisation, but at the same time increasing economic growth (European Commission, 2010). Security is addressed separately in, for instance, the Container Security Initiative (CSI) and the Customs-Trade Partnership Against Terrorism (C-TPAT). The latter involves multiple countries, and promotes the use of best security practices. Shippers and carriers that certify the use of best security practices are given expedited processing at US ports of entry. Manufacturers, importers, carriers, and third-party logistics service providers can all participate by completing detailed questionnaires and self-appraisals of their supply chain security practices, while Customs would perform periodic audits and verifications of such practices. Globally, the concept of Authorized Economic Operator (AEO) has been accepted and is implemented by many countries reflecting these self-appraisal and periodic audits (Rukanova, et al., 2011).

Information sharing amongst all actors participating in global trade and logistics to meet societal demands is required (Hofman, 2011a). From a security perspective, it results in the so-called data pipeline in which shippers, logistic service providers and carriers share data (Heskhet, 2010). Synchro-modality increases sustainability by seamless switching between transport modes based on sharing real-time information (Overbeek, Dignum, Hofman, & Tan, 2012). Models have been developed for business interaction taking for instance a cargo centric approach (Schumacher, Rieder, & Masser, 2010) or business to government interaction (World Customs Organization, 2009). All efforts still lead to closed communities in which actors made agreements on information sharing (Hofman, 2011a), which thwarts smooth and secure information sharing between global supply chain actors. To overcome this difficulty, this paper introduces an open platform by which communities can agree upon requirements for sustainable, safe and secure logistics. Semantics is crucial for achieving interoperability, but other, both organizational and technical, aspects need to be agreed upon as well. The functionality of social networks (Kietzman, Hermkens, McCarthy, & Silvestre, 2011) is a basis for defining the functionality for a platform in logistics. The methodology used is that of design science (Hevern, March, Park, & Ram, 2004). By analyzing the current situation and formulating new concepts, new IT artifacts are proposed. These artifacts can be used in a federated manner, enabling that multiple providers can offer the components.

Section 2 introduces the functionality of the platform based on business requirements and analyzing the functionality of similar Social Media platforms. Section 3 gives the implications of this functionality for the implementation of such a platform. Finally, section 4 presents conclusions and further research.

2. Functionality for secure, safe, and sustainable logistics

This section analyses the need for business to collaborate and share information. An analogy with social media is made as input to the functionality of a platform for secure, safe, and sustainable logistics. First of all, logistics collaboration is discussed, secondly, social media functionality is provided and finally the functionality for the platform is presented.

2.1 Collaboration in logistics

This section briefly introduces two types of collaboration in logistics (or more general in business), namely logistic services for value exchange and information sharing on resource availability. Both are closely related to each other as we will show.

One can distinguish two types of resources, namely resources of which ownership is transferred from one organization to another and resources that are used for this exchange (Hruby, 2006). Logistics is transport, transshipment, and storage of products for production and final delivery to retailers and/or customers utilizing various types of resources. Products can vary, e.g. parts, electronic equipment, pharmaceutical products, and agricultural products like flowers and milk products. Each of these products has specific logistic requirements like temperature setting during transport. These logistic requirements are implemented by different packaging and resources like trucks, containers, and vessels. Transportation of these products can pass many borders, thus involving different authorities from different countries. Different actors share information to optimize the logistic activities and coordinate logistic flows (figure 1). This so-called three layer model for global logistics distinguishing physical, logistics, transactions amongst businesses and the government shows that basically different logistic activities can be performed, e.g. inland transport by truck or barge and sea transport by vessels, and actual execution of these logistic activities can be arranged by various actors, e.g. a forwarder and a shipping agent. The information shared amongst those actors concerns the logistic activity or value proposition (Spohrer & Kwan, 2009) offered as logistic services of an actor, relevant product and packaging information and the resources used for performing logistic activities. The information can be very well structured. Authorities operating in the government layer, e.g. customs, monitor these flows for risk analysis (Hofman, Supply Chain Visibility with Linked Open Data for Supply Chain Risk analysis, 2011).

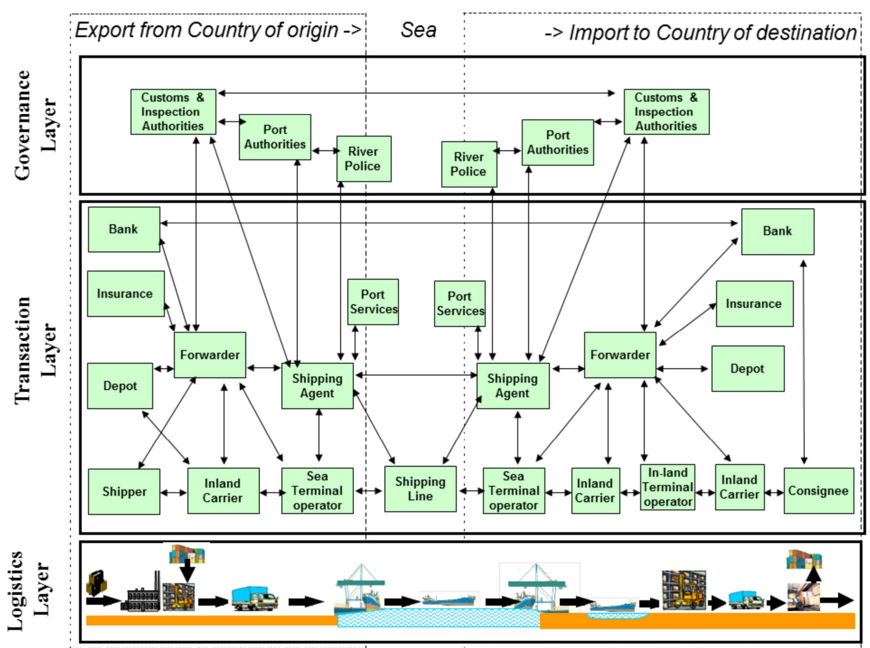

Figure **1** Layered model of global supply chains (Hintsa, 2012).

To perform logistics activities and optimize resource utilization, information is shared in three phases (Dietz, 2006): (1) the booking phase to prepare the execution of a logistics activity by exchanging general requirements like number and weight of packages, locations, and expected times for performing the activities, (2) the execution phase in which the activity is actually performed and details of the cargo and resources utilized like sailing schedules of a vessel, and possibly (3) a cancellation phase in case a booking does not result in an order or the cargo cannot arrive in time at a certain location for the next logistics activity. These phases together constitute a business transaction between two actors (Hofman, 1994).

Before actually executing a logistic service, the use of particular resources might be optimized, e.g. by picking up several consignments to get a full truck load and efficiently planning delivery of a container at a sea terminal at the proper gate and the proper time with traffic jam prevention based on traffic information. Increasing sustainability requires actors to collaborate during the preparation phase by for instance bundling consignments (demand optimization), resources like trucks (supply optimization), or a combination of both. It requires customers to share information on consignments and logistic service providers and carriers to know of available capacity. The latter requires a gain model in which all participants share part of the profit, since transparency of capacity is commercial sensitive for a lot of logistic service providers and carriers. It also requires that customer properly specify their requirements, without selecting a particular transport mode, like inland waterways, rail or road, or a particular transport means.

Collaboration is not only required during the preparation phase of business transactions, but also by accessing (nearly) real-time data for planning optimization and handling exceptions like traffic jams. It enables organizations for instance to have a barge available at the proper place and time in a port. This type of collaboration requires visibility on supply chain data. An example is visibility of container arrival for staff planning to strip these containers and compose consignments for delivery of cargo to their final destination (e.g. a retail store).

Figure 2 gives an overview of information requirements. Compliance and sustainability are both applicable to business and authorities. Value exchange is relevant for business and will be monitored by authorities from a compliance perspective. Information requirements depend on the scope, e.g. compliance requires information on people and entities like traders, cargo, and containers active in supply chains and real-time planning requires place and time of these entities to take action. This overview is not complete, e.g. information requirements for incidents are for instance not listed.

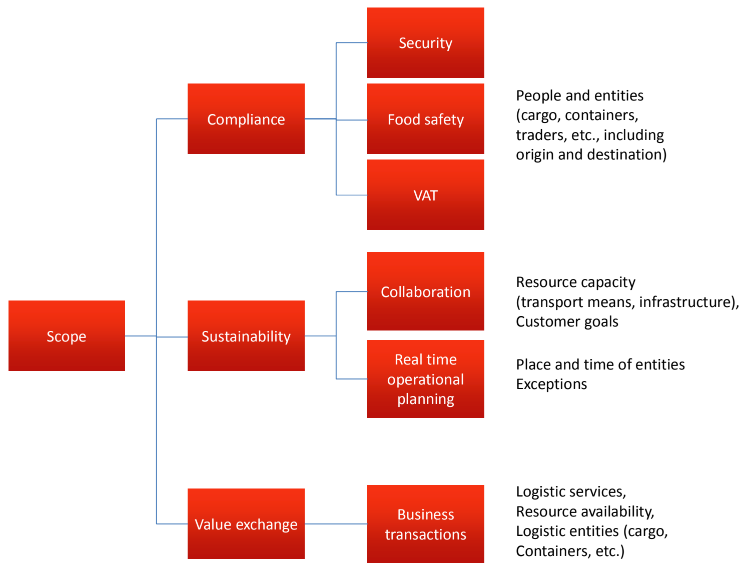

Figure **2** Scope of information requirements.

2.2 Social Media

Logistics is about cooperation and collaboration of many organizations, either in communities like ports or for a particular product like flowers, and/or in supply chains. Social Media is all about cooperation and collaboration amongst individuals. Social Media functionality might be a basis for specifying functionality for a logistics platform. Therefore, this section analyzes Social Media functionality and its applicability to logistics.

Traditionally, individuals used Internet as consumers to simply expend content to read it, watch it and use it for buying products and services (Kietzman, Hermkens, McCarthy, & Silvestre, 2011). Increasingly, individuals also took the role of producer and added value by co-creation (Payne, Storbacka, & Frow, 2008) leading to an explosion of data also known as Big Data. Individuals use platforms like Twitter, Youtube, and Facebook for content sharing and collaboration. Kietzman (Kietzman, Hermkens, McCarthy, & Silvestre, 2011) analyzed these platforms and came with the so-called honeycomb for social media representing the functionality of social media and implications of the functionality (figure 3). The implication of an identity is for instance the existence of data privacy controls and tools for self-promotion, whereas communities will have membership rules and protocols. It must be noted that privacy is still a paradox in social media, since a user with data stored for all relevant functions is in fact the product of a social platform (Barnes, 2006).

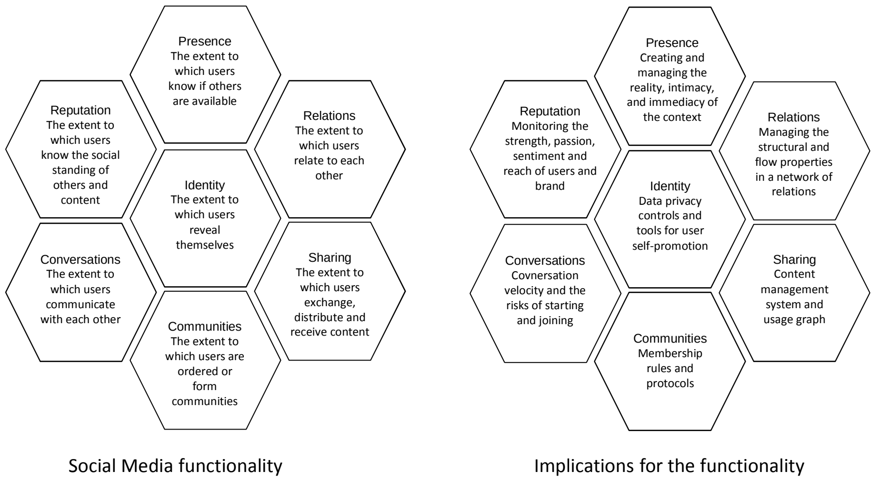

Figure **3** Social Media Functionality (Kietzman, et al. 2011)

The functionality is more or less self-explaining and can be easily recognized, e.g. by creating a profile a user will have an identity on a particular platform like Facebook or LinkedIn. The functionality is implemented in different ways. A user with its identity can for instance share information with anyone using a blog or a wiki, but a user can also share this information with only one other user in the context of a relation. Conversations can take place in a discussion forum of a community and a community can be used to share information amongst its members. The above shows that individuals and communities are at the core of social media. The way in which functionality can be used depends on the platform offering the functionality. Social Media Functionality is not implemented by one platform, e.g. Facebook and Google+ offer similar functionality. There are ontologies specifying what data can be stored in these platforms, e.g. Friend of a Friend (FOAF) for identity and Semantically-Interlinked Online Communities (SIOC) representing functions with content in communities like fora with their posts. These ontologies can be used for sharing instances amongst platforms, but they are most often not implemented by these platforms[1]. Integration amongst social media is most often on conversations and sharing based on functions they offer (e.g. iLike for Facebook). From a security perspective, single sign on for access control is applied by social media and also OpenID can be used. A WebID is also defined based on FOAF, but this identification mechanism is only used by a limited number of services on the web.

To analyze the applicability of social media functionality for business (more specifically logistics chains), we need a definition of Social Media: Social Media is a group of Internet-based applications that build on the ideological and technological

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[1] Sharing data amongst social media depends on the business model of a social media provider. Instances like individuals are the assets of a social media provider in case the provider has a revenue model based on for instance advertisements.

foundations of Web 2.0, and that allow the creation and exchange of User Generated Content (Kaplan & Haenlein, 2010). User Generated Content in its turn mainly relates to content that is used for various purposes, e.g. news, chatting, professional (Balasubramamiam, 2009). Depending on its purpose, the content is for instance voice, music, text, and video in different technical representations published via particular social media platforms like a discussion in a forum. This User Generated Content has one or more creators and might have Intellectual Property Rights (IPR), e.g. music with one or more creators and performers. Ontologies like FOAF and SIOC modeled content in terms of its appearance (e.g. a blogpost or a post in a forum) and did not model content with its relation to individuals like creator, performer, etc. SIOC and FOAF use Dublin Core to insert this type of metadata (Dublin Core Metadata Terms, 2010).

2.3 Logistics Collaboration Platform

Whereas Social Media consider multimedia content, collaboration in logistics requires sharing of structured data, either for value exchange or collaboration as explained earlier. Like Social Media, a logistics collaboration platform is constructed round two core concepts (figure 4), namely identity and community. In subsection 2.3.1 the functionality of the platform is described for the topics derived from the functionality of Social Media functionality as discussed in section 2.2 and graphically illustrated in figure 3. Additionally, semantics, security and privacy, and distribution of the functionality are three other important concepts in a Logistics Collaboration Platform. We discuss these concepts separately in the subsequent subsections. Subsection 2.3.2 elaborates the role of semantics since it is the basis for business transactions and collaboration. Next, subsection 2.3.3 presents the privacy and security aspects followed by a discussion on the distribution of the platform functionality (subsection 2.3.4), finally leading to governance issues (subsection 2.3.5).

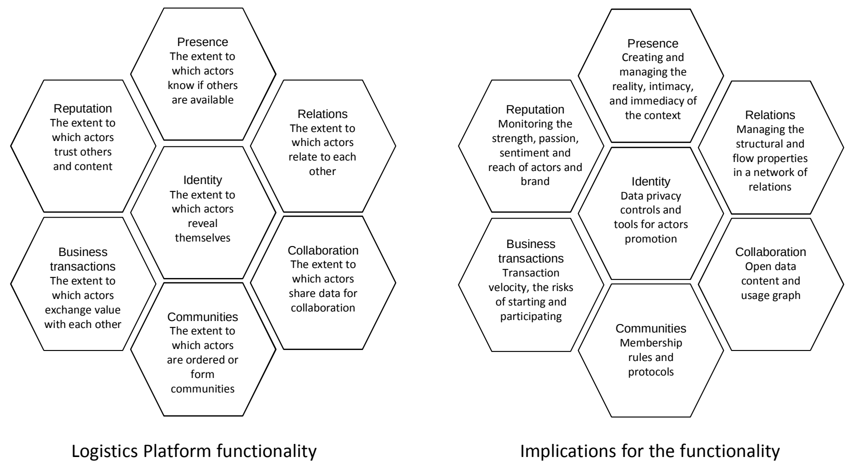

Figure **4** Logistics Collaboration Platform functionality

2.3.1 Functionality of the platform

The functionality of the platform for each of the concepts shown in figure 4 and their implications are described as:

- *Identity*
  This function reflects the way in which an organization reveals itself by publishing its services. It comprises a basic description of an organization with its services and data. These services specify the value proposition of an organization, which could also comprise prices and conditions. Whereas value propositions relating to physical products normally give prices and conditions, those of logistic service providers and carriers will only be available to potential customers during the preparation phase of a business transaction. Like in Social Media, identity requires privacy controls, e.g. commercially valuable data is not disclosed to unauthorized persons.
- *Community*
  This function refers to the governance of agreements made amongst organizations. Membership rules and protocols are therefore important.
- *Reputation*
  Reputation reflects the former behavior of a particular organization, e.g. in terms of payment and service delivery in accordance to agreements.
- *Presence*
  Presence not only comprises the published value propositions, but also all other ways an organization is publicly active, e.g. in discussion on sustainability.

- *Relations*
  Relations amongst actors can exist for various purposes, but we will basically distinguish relations for business transactions and collaboration. In case there is a market, relations will only exist per transaction. Otherwise, relations will be more stable and lead to (long term) contracts (Williamson, 1975).
- *Collaboration*
  This function supports resource optimization during the preparation phase of business transactions and supply chain visibility for planning optimization as described earlier. Collaboration can also be part of business relations specifying how organizations share data on orders and resource availability in a contractual relation.
- *Business transactions*
  The business transactions represent the actual value exchange amongst organizations in logistical chains utilizing particular resources like trucks and containers. This function requires business transaction management, i.e. process orchestration of business transactions with customers and related business transactions with subcontractors. Process orchestration has a dependency with collaboration and contributes to the reputation of an organization.

Not all of this functionality is new. Parts are implemented by existing systems, implying that a more detailed specification of the functionality can be used for software selection, e.g. a systems supporting the functionality of relations implemented by a Customer Relationship Management (CRM) system or business transactions by operational transaction systems. However, other IT systems can be applied for instance social media dashboards like Hootsuite linked to a CRM application for managing one's reputation and presence in Social Media and Business Intelligence (BI) in combination with a dashboard for managing ones performance indicators. Supply chain visibility platforms currently provide visibility of business transaction data (Hintsa, 2012), which is however not the type of (nearly) real-time data required for planning optimization. Linked Open Data might offer an alternative solution in this perspective (Hofman, 2011b). Communities are for instance supported by a Business Community System (BCS) provided regional in for instance a port and globally supporting particular supply chains of shippers and LSPs. They provide various functions based on business document exchange, either based on agreed standards in a community (like in a Port Community System) or supporting their customer requirements (like in a commercial system).

Thus, we already have a lot of functionality, but each IT component will have its particular semantics and processes. Having these components implies that the functionality will be distributed and interfaces have to be created. Distribution of functionality leading to a federated system is discussed in section 2.3.4.

2.3.2 Semantics

Like Social Media, a Logistics Collaboration Platform requires semantics supporting the various functions. A semantic model should not only support business transactions and collaboration (the 'content' exchanged or shared across a platform or medium), but also a representation of organizations and communities with their agreements like defined by identity is modeled by FOAF and groups by SIOC for Social Media. Semantics should model on the one hand logistic activities that can be supported and on the other hand the physical objects like cargo and containers (section 2.1). However, there are still choices to he made, represented by different modeling levels in figure 5:

- *Modeling level 1: business concepts.*
  Since logistics is a particular business area with its own and common business rules, it is possible to apply particular business concepts like value propositions (Spohrer & Kwan, 2009) and resources (Hruby, 2006) in relation to place and time. Applying these business concepts will make it easier to support cross-sectorial collaboration and business transactions by extending a semantic model with new types of resources, etc.
- *Modeling level 2: Logistics Core Model.*
  This modeling level considers two aspects, namely specification of generic concepts and representation of semantics. Both are discussed.
  Logistics has a variety of roles related to for instance organizations (e.g. shipper, forwarder, and carrier) and places (e.g. place of acceptance, dispatch place, port of loading, border place, and pick up place). These roles relate to the physical process, but still refer to the same organization or place. Roles can be modeled as concepts, but also as rules. Modeling them as concepts gives a large semantic model, whereas modeling them as rules makes a model not acceptable by business and authorities. A solution is to construct a semantic model (a Logistics Core Model) having these roles as rules and deriving specific models out of this core model for particular organizations. The core model can be used for supporting various transformations amongst organizations, since it is the most flexible and complete.
  Semantics can be represented in different ways, e.g. by a Unified Modeling Language (UML) class diagram or Ontology Web Language (OWL). We propose to use the latter one, whilst it supports rules, concepts can be re-used via referencing which allows distributed maintenance (see governance issues), and specialization is supported.
- *Modeling level 3: detailing the Logistics Core Model by a class diagram.*
  In global logistics, different languages are used. By applying agreed code values, e.g. for packaging, IT systems are able to support these multiple languages. Code values are a representation of concepts and conceptually a constraint on values of concepts. Other types of constraints are the format and data types. A core model will not specify these types of constraints, but a specific model will. Generic representations of concepts will support interoperability amongst specific models.
- *Modeling level 4: technical representation of data (syntax).*
  Data, called instances in OWL, can be represented in different ways, e.g. in Resource Description Framework (RDF), eXtensible Markup Language (XML), or any internal representation used by a data store. Tooling could be available to support these different formats.

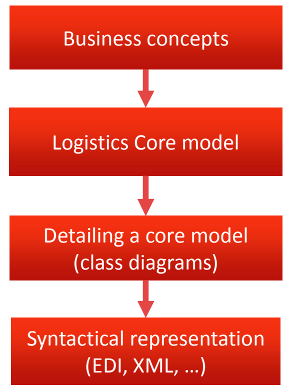

Figure **5** Modeling levels

Interoperability currently comprises modeling level 3 and 4, whereas level 3 models developed by different organizations differ, e.g. the WCO class diagram differs from the Common Framework. Developing a level 2 model represented in OWL supports re-usability, localization and extensibility, but requires abstraction from many terms used in current operation. Applying business concepts in developing a Logistics Core Model enables business transaction and data sharing with other application areas. A Logistics Collaboration Platform is thus a specialization of a more generic Business Collaboration Platform, which leads to the conclusion that different types of platforms for business collaboration can co-exist (Hepp, 2006).

2.3.3 Privacy and security

Unlike the current approach for Social Media, data privacy and security is very important in logistics. Logistics data contains commercial relations between organization including agreements and costs and should therefore only be disclosed to authorized organizations and persons. As Logistic Service Providers (LSPs) and carriers are responsible for handling (high value) products of others, they are also liable up to a certain amount (United Nations, 2008).
Data privacy and security therefore needs to cover:

- *Liability*.
  What data is required by an LSP or carrier for actual value exchange? In case a service provider does not have and does not require data of for instance the actual content of a container but only a broad description (STC: Said To Contain), that provider can only be held liable for loss or damage for a particular amount, e.g. cargo weight.
- *Data visibility*.
  Who has access to particular (real-time) data, e.g. for collaboration or inspection (to govern security and food safety)? Data visibility is not only required for collaboration amongst organization operating in logistic chains,

but also from an authority perspective (Hofman, 2011a). Different mechanisms can be implemented, e.g. Role Based Access Control is probably the most well-known and applied in practice. However, in a dynamic environment roles of an organization differ per supply chain configuration. Access control thus needs to be related to one's role in a particular supply chain, also with respect to goods flows. Organizations like shippers/consignees, LSPs and carriers basically can have access to data of others if they have agreed as such for collaboration. However, they should only have access to that data of business transactions in which they are service provider and customer, unless granted otherwise (e.g. full supply chain visibility). Authorities should only have access to data of incoming and outgoing cargo flows types of goods (e.g. agricultural goods) in the territory they govern.

Liability and data visibility require identification and possibly other IT security mechanisms like electronic signatures giving proof of data stemming from a particular source. We will discuss that the choice of an identification mechanism depends on the implementation of the functionality (section 2.3.5).

2.3.4 Federation: distribution of the functionality

This section discusses a number of implementation options leading to additional requirements to for instance interoperability and IT security. First of all the implementation options will be discussed and secondly interoperability and IT security requirements are discussed.

We have already indicated that there is a lot of software available to support the various functions of a Logistics Collaboration Platform, although some functionality like real time data visibility is not yet supported. Furthermore, quite a number of organizations has existing software or uses (commercial) services of providers. Basically, three different approaches to implementation of the functionality are possible, namely (1) a central, global system, (2) systems run by each organization (completely decentralized solutions), and (3) a hybrid solution consisting of central and decentralized systems. The first option is not feasible, based on the argument that already organizations and IT software and service providers have invested in existing IT systems. A complete decentralized solution requires that also Small and Medium Sized Enterprises (SMEs) require IT functionality, which will also not be feasible. Thus, the third option is the most likely option for realization of the platform: a combination of several IT components implemented by one organization or operating on behalf of more than one organization, either owned by these organizations (e.g. BCS) or offered by a commercial service provider as a type of cloud service.

A hybrid solution requires interoperability amongst all IT systems supporting the functionality. The semantics identified earlier can be the basis for specifying interoperability in combination with the business transaction phases identified earlier. However, existing solutions already support particular semantics and interoperability solutions. Transformation between these solutions and the common agreed mechanisms need to be established. This aspect also relates to governance and standardization issues relevant to communities: is there one common semantic model or do we need to have multiple (bilateral) transformations based on standards and models agreed in different communities (see section 2.3.5).

Having a hybrid solution implies that also more than one identification mechanism with different types of certificates needs to be supported. Authorities operating in the government layer (Hintsa, 2012) within a country will for instance define their identity mechanism that can be used in collaboration with them. Traders can also make particular agreements on the identification mechanisms used. Protocols need to be established for collaboration and business transactions amongst organizations utilizing different identification mechanisms (Berg, Pruksasri, & Hofman, 2012). Having these protocols makes it possible for an organization to use its certificate globally, it will for instance offer a customs authority access to a foreign database to retrieve all required data of incoming and outgoing goods flows in the territory of that authority. The biggest challenge here is to build up international chains of trust.

2.3.5 Governance issues: communities

A hybrid solution leads to various aspects that have to be agreed and require governance: certificates of different Certification Authorities (CAs), different semantics and interoperability solutions, and liability and collaboration aspects. Whereas one organization like a large, globally operating shipper, an association of carriers like the IATA for airline carriers and an organization like the World Customs Organization (WCO) implement governance for their agreements, it will lead to closed communities with their agreements and governance structure. We will discuss the identified governance issues briefly; these issues do not concern governance of, for instance, a BCS. In this paper, governance relates to the tension between the solution of an (individual) organization having its particular interoperability requirements and agreements made within a community. One organization may want to distinguish from its competitors based on for instance its logistic services and technology used for collaboration.

Accepting different certificates issued by CAs requires besides the protocols and gateways identified in (Berg, Pruksasri, & Hofman, 2012) also the acceptance of different CAs. This can be a political issue in case for instance government authorities in one country do not recognize a CA used by authorities of another country. These political issues might relate to establishing trade relations between countries for instance by recognizing each other's Authorized Economic Operator (AEO) certificates.

A second governance issue is semantics and interoperability solutions for business transactions and collaboration. It can be further broken down in process aspects and technical solutions, different semantic models with different representations, and re-use of semantics. These aspects are discussed further.

Basically, process approaches supported by technical solutions concern the way data is shared between processes of different organizations, e.g. asynchronous processes synchronizing by messaging supported by solutions like Electronic Data Interchange (EDI) or eXtensible Markup Language (XML). Data retrieval as input for business processes can be supported by web services. B2B business transaction support and collaboration can easily adopt changes, if there is a clear business case.

Process approaches and technical solutions for B2G might involve political and legal considerations, e.g. business is currently obliged to submit declaration data to customs based on legal solutions, although some customs authorities consider to implement approaches like System Based Auditing (SBA) with continuous transaction monitoring or sampling.

The second aspect of semantics and interoperability concerns different semantic models. Semantic models specified as Unified Modeling Language (UML) class diagrams are available to support the Single Window concept (Van Stijn, et al., 2011), e.g. the WCO data model (World Customs Organization, 2009). On the other hand, UML class diagrams are defined for logistic chains (Schumacher, Rieder, & Masser, 2010). Although both models use the same representation, they differ in terms of classes and attributes. Whereas the WCO data model takes a declaration approach, the UML class diagram for logistics is based on logistic services. Furthermore, UML has no formal approach, which makes re-use of models difficult. The semantic web introduces yet other open standards like Ontology Web Language (OWL) for representing semantics that supports re-use of definitions. Thus, both at technical and semantic level there are different solutions that need to be supported. A semantic model specifying basic logistic concepts could serve as a basis for transforming between all options. These transformations have to be supported by tools to make them machine-readable as configurations.

The third aspect of semantics and interoperability considers re-use of semantics. In this respect, governance of semantics constitutes dependencies of different semantic models based on referencing as supported by for instance OWL. OWL supports the specification of for instance a global semantic Single Window model, which can be localized to a particular country and specialized for a particular type of application like import declaration in that country. Such a global model of for instance Single Window and/or logistics can be governed in a global community like the WCO, a localized model by national authority, and an organization with its trading community governs its part of the model. As such, a community with its relations to other communities acts as a Data Governance Authority in relation to agreements made for identification. Such an authority is also known as a Standardization Organization (Folmer & Punter, 2010).

Data Governance rules are part of access control, e.g. they represent the type of data that can be accessed and shared amongst organizations. Organizations agree in communities which data they will share, based on internationally agreed rules like shown before. These rules also implement liability and collaboration aspects, for instance the Rotterdam Rules (United Nations, 2008) can be implemented in a community as a specialization of a generic semantic model for logistics specifying data that carriers can share in the context of liability.

3. Implication the platform

The previous section shows that the community concept is important in all respects, e.g. semantics, technology, and certificates. It shows that we can have different communities for different purposes, e.g. a community of for instance forwarders or container stevedores that specify in terms of the Logistics Core Model their data requirements. The functionality of a logistics platform (1) supports interoperability between current closed communities based on re-use of existing Interoperability Implementation Guides (IIGs) by referencing to sources and adjusting them to specific requirements in a community, (2) supports agreements on data sharing in a community considering legal constraints, and (3) allows place and time independent operation of business and authorities. These improvements will be elaborated.

The first improvement relates to the fact that there are many standards, all (slightly) different specifying interoperability in logistics from a certain perspective (e.g. shipper, authority, carrier, and an overall approach like the Common Framework). These are only the interoperability standards developed and used in Europe and intercontinental logistics, the IIGs for other continents will probably differ. Lack of interoperability of these different standards and their implementation guides leads to closed communities. Logistic Service Providers have to cater with the different standards of their customers, carriers, and authorities to be able to support their service offering by electronically sharing data. Re-usability of semantics improves compatibility amongst communities and therefore interoperability. Implementing IIGs of different communities becomes easier for an individual actor if these communities share the same semantics. IIGs based on the same semantic model will be consistent, leading to a decrease of implementation cost.

The second improvement allows communities to define their objective for collaboration (see also figure 1) and specify their own rules and protocols under consideration of legal constraints. Liability is one of the legal constraints in global logistics as formulated in the Rotterdam Rules (United Nations, 2008). The impact is that actors only share that data that is required for value exchange related to their particular service. In practice it means that, for instance, a shipping line or forwarder is not aware of the actual content of a container in the context of a transport service, but only needs a general goods description (STC: Said To Contain). On the other hand, the same forwarder may need a more specific goods description in case the forwarder not only arrange transport but also performs the export declaration on behalf of a shipper. Thus, in one community, actors agree on data shared for transport services considering liability, whereas in another they can agree on data sharing for declaration services considering customs regulations. From an auditing perspective, a general rule of a community offering transport services can be that if an actor also offers declaration services, the transport services have to be implemented in such a way that they cannot retrieve any information of the declaration services, whereas the implementation of declaration services can. Such rules between communities have to be implemented by an organization participating in those communities, e.g. in their internal procedures and IT systems.

The third improvement is a basic one considering a Semantic Web perspective for trade and logistics: business can operate place and time independent from authorities and each trader is a potential data source for an authority. The platform and its security mechanisms allow authorities to govern goods flows by monitoring trader data, independent of the place at which traders have their operation. This improvement implies that traders do not have to pay agents offering customs services to authorities in countries where these traders do not have offices. Depending on trade volumes and costs of customs services, this can lead to huge savings for these traders. Authorities have to accept this approach based on political and legal decisions.

4. Conclusions and next steps

This paper presents functionality of a flexible platform for secure, safe, and sustainable logistics derived from similar functionality for Social Media. The platform supports for instance communities in which agreements can be made for data sharing. Examples are a customs - and a Single Window community with agreements on data required for compliance (section 2.1) or a carrier community with data sharing in the context of liability (section 2.3.3). Like with Social Media, the platform can be implemented by different providers, and each provider can implement parts of it. A provider can be an organization participating in logistics, but can also be an IT service provider for logistics. Due to the fact that a lot of functionality is already available either in software or interoperability messaging and models, the platform has to support different types of transformation and process approaches supported by technical solutions, but also innovative approaches based on the Semantic Web. There are still a lot of issues identified in this paper that need further research:

- The scope of business requirements that should be supported by the platform resulting in data requirements and supporting technology.
- Issues of semantics identified in section 2.3.2.
- Various governance issues that may give new requirements to the platform (section 2.3.5).
- Further specification of organizations and their logistic services, semantics and supporting technology constituting a logistic service profile of an organization.
- Functional and non-functional agreements including management and distribution of certificates and considering liability issues as made in a community.
- Access control mechanisms based the concept of node in a transaction tree representing the transactional layer (Hintsa, 2012) in a logistic chain.
- Further research on the implications of the platform to authorities and business from different perspectives (e.g. IT systems and benefits).

The result of further research will provide more detailed requirements to platform components like transformation functionality between different communities.

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