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Common assessment and analysis of risk in global supply chains

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1 CASSANDRA vision and objectives

1.1 Introduction

Due to globalisation and automation, international supply chains have become more dynamic and more complex over the recent years. The commercial transactions, organisation of logistics and execution of transport are performed by multiple layers of organisations, all connected by contracts of sale and carriage. And as a consequence of logistics effiency developments like the introduction of sea container transports and consolidation of cargo, more and more goods were concealed from supply chains visibility. Concepts like outsourcing of activities, consolidating cargo from multiple shippers and transporting across multiple modes of transport (sea, air, road, rail, river) have complicated the organisation and control of the chain and demand more from the involved companies in terms of collaboration and information sharing. The legal framework around international trade & logistics makes it even more complex and unpredictable. Cross-border formalities and inspections are major barriers to global trade. In the 2013 report, Enabling Trade: Valuing Growth Opportunities, the World Economic Forum and Bain & Company found that reducing supply chain barriers could increase the world's gross domestic product (GDP) by over US$ 2.5 trillion. Supply chain inefficiency accounts for 30% of food that is lost or wasted between harvest and consumption[1].

This proves that within trade supply chains there is still a lot to be won. The answer to that is supply chain visibility and re-use of trade information along that chain.Next, the challenge is how the trade internal efforts to achieve this visibility and re-use of information as the are being in control, data-exchange and transparency can be balanced with safeguarding the fiscal, security and safety interests of society, or could even go hand in hand. CASSANDRA has shown that this is possible. On the one side achieving increased optimization of supply chains which leads to taking away the inbalance in coststand trade risks,on the other side serving cross-border formalities and inspections with hardly any additional effort. These seemingly conflicting issues have a common solution: the *Pipeline Interface*, a supply chain control, and transparency solution, where data can be shared between businesses and business and government and where applicable, can be send seamlessly to governments. For businesses, enhanced supply chain visibility based on accurate data means better predictability, resulting in cost reductions and better aligned processes along the value chain (supply chain synchronisation). This enhanced visibility and data accuracy allow governments to perform better risk targeting, thus safeguarding societal interests more effectively. And accessibility of trustworthy trade data opens up new supervision concepts that are able to better facilitate international trade. This is also confirmed by a resent study of the World Economic Forum, that refers to CASSANDRA in the frame of the European eCustoms dand eFreight initiatives[2].

A remarkable research result is that no common business case can be determined for the data pipeline concept, but that almost all supply chains can benefit in one way or another from this supply chain visibility solution. Where a logistics service provider can better plan his transport, because he has more knowledge of the whereabouts of the cargo, a shipper may be able to reduce the company's capital blocked in his floating stock, because he can better manage the transport times, another party may be better able to reduce mismatches between order and delivery and even supply chain finance can benefit as the trade which is financed

[1] See Moïsé, E. and S. Sorescu (2013), "Trade Facilitation Indicators: The Potential Impact of Trade Facilitation on Developing Countries' Trade", OECD Trade Policy Papers, No. 144, OECD Publishing.

[2] World Economic Forum, Connected World - Hyperconnected Travel and Transportation in Action, In collaboration with The Boston Consulting Group May 2014.

becomes more visible. And let's not forget, although many are reluctant to share information, managing data in the pipeline concept shows who is able to re-use which information for what purpose. Something one can never oversee in a paper or email exchanging world.

Key CASSANDRA concepts

The key CASSANDRA concepts include:

1. ***Data Pipeline***. This information architecture enables capturing and sharing data from different sources in an interoperable way and visualise the integrated data in the best suitable ways for both businesss and customs, by different dashboards and dashboard interfaces. A data pipeline is built by inter-connecting the different IT-systems of all parties in the supply chain. The technical challenge was to develop the right interfaces for the inter-connection of all these IT systems; XML standards and ontologies were the key solutions for this. The data pipe line can be compared to the way the Internet is working via a network of inter-connected servers all over the world. In CASSANDRA, the data pipeline provides the enabling technology to capture ***data from the source***, share it and to visualise the integrated and validated data in a way that it supports decision makers along the chain on operational, tactical and strategic level. Since many technical solutions already exist, the IT challenge lies in integrating solutions across the supply chain to achieve enhanced **chain visibility**. But the bigger challenge is to overcome the reluctance to share data. Data from the source is a powerful principle that might sound obvious, but the project found that it is not. The basic principle in four hundred years of international trade & logistics evolution is that data are only shared among the value chain if it is needed to perform a value added activity in the chain. As a consequence, data are being aggregated, and connecting different trade transactions, shipment data, container data and status information becomes a puzzle, resulting in all kinds of suboptimal solutions and practices. The owner of the initial information not knowing who is holding his info and what it is being used for. The power balance along the chain and the scope and size of the inefficiencies determine the success in overcome these shortcomings. CASSANDRA also took into account the role of border inspection agencies in this multi-stakeholder game. The current supply chain security declaration procedure does not work effectively. CASSANDRA showed that asking an ocean carrier to submit pre-arrival data on consignors, consignees, cargo details and other commercial details is fundamentally flawed as these actors are not capable of, willing or intrinsically motivated to ensure submission of source data or the validation of the quality of the data. And contrary to the most common legislative action to simply demand more data from the same person when the provided data are not sufficient, the supervision model of border inspection agencies needs to recognise this and the supply chain security framework needs to be readjusted and redesigned.
2. ***A risk based approach that allows for piggy backing on business and chain controls.*** Second key CASSANDRA principle is to better determine risks of all kinds in the supply chain, leading to less false physical checks and thus reducing the trade transaction costs involved whilst maintaining or even improving the effectiveness of the supervision. In addition to Customs there are other border inspection agencies such as the inspections for food- and product safety, hazardous goods etc. However, as customs has a coordinating role for all border inspection agencies in many countries, we focused on customs interventions. Next the principle of lifting along with trade data in customs supervsion. Instead of demanding more and more info on top of customs declaration data, customs simply take a look in the trade data chain via a dashboard, which reduce administratieve burdens for trade and government substantially. And customs can even piggy back, where possible, on business driven control measures that are already incorporated by commercial actors in the value

chain. The tallyman procedure described above is a nice example of this piggy back principle. If alternative methods of control need to be executed, implement them in such a way that they minimise disruptions and administrative burdens in the supply chain. CASSANDRA elaborates on the applicability of ***piggy backing*** by incorporating ***chain control*** mechanisms. These controls are across and within organisational boundaries and are often pushed upstream, while their benefits manifest in downstream value chain activities.

Illustrative example: EU-China import case

In one of the living labs of CASSANDRA a large retail company in Europe was struggling with improving the visibility of their supply chain from China. This company purchases a wide variety of different products from their suppliers in Chain. For the suppliers it is cheaper to ship their products in one single container to Europe than to have their products consolidated with the products of another supplier in one container, because this consolidation process is arranged by a freight forwarder that charges extra costs to the supplier for this consolidation process at the container stuffing point. However, this leads to extra costs for the retailer, because, for example, products of two different suppliers that could have been combined in one single container, are now shipped in two different containers, and the retailer has to pay for the costs of shipping this extra container. It appeared that this happened with about 15% percent of the containers in this supply chain of this retailer. Hence, the retailer wanted to have more visibility in the supply chain and to have checked precisely what goods were stuffed in the container at the container stuffing point in China. A third party was hired,a so-calledc tallyman, to do this checking at the contained stuffing point, and the 15% inefficiency in this supply chain was reduced to almost nil due to this increased visibility. At his point the Cassandra project kicked in. This tallymen was an excellent opportunity to get accurate data from the real source where the goods are stuffed in the container. For his check the tallyman produces a packing list file. By connecting the information system of the tallyman with the information systems of the freight forwarders at both ends of the supply chains access could be provided for the customs in Europe to query the data in the packing list file of the tallymen. In this way a Data Pipeline was built from China to Europe that makes the container packing list data of the tallyman real-time accessible for the retailer as well as the customs in Europe. Both got what they wanted; more accurate data about the what goods where in the container. The retailer needs this accurate data to reduce inefficiencies and costs of its supply chain, and the customs needs this data to be able to do a proper risk assessment of the container for import in Europe. This living lab is also an excellent example of the so-called Piggy-Back principle; the customs is re-using control procedures (i.e. the tallymen) and business data (the packing list data) for their own control purposes. At the end this should not come as a surprise; the importer and the customs need exactly the same data accuracy about the imported goods in the container to make their own processes more efficient and effective. An additional benefit of this data pipeline and the piggy-back principle is that when customs gets more accurate data from the source, changes decrease that such containers will be selected by the customs for physical inspection at the EU border, because customs typically inspects containers when they are not sure about the content of a container. Less insepections implies less costs for the importing retailer, because all the actions needed for a physical inspection of a container (transport from the terminal to the inspection site, opening and unstuffing of the container, inspection of all the goods in the container by the customs inspectors, re-stuffing the container, transport from the inspection site back to the terminal etc.) costs typically a couple of hundred euros per container and can cause serious delays. Hence, by reducing the changes that a container is selected for inspection, the CASSANDRA solutions can make a substantial contribution to the improvement of trade facilitation.

Understanding supply chain risk management

The ambition of joint analysis of risks along supply chains – directly following from the acronym CASSANDRA - starts with understanding supply chain risk management practices, the first step in a risk based approach. The current practice of risk management is that risk management along value chains consists of four components: (1) avoid risks, (2) transfer risks, (3) accept risks or (4) control risks. The way economic actors deal with risk is driven by economic rationale. Risk avoidance is for example to not enter into a contractual relationship with a certain trader, despite the fact that not doing so would mean less turnover. Risk transfer is a common practice in fragmented supply chains. Risk transfer often includes outsourcing in combination with contractual control, for example applying certain Incoterms. Controlling risks often means implementing control mechanisms, including the corresponding investment. These mechanisms can be broadly split into two categories: internal control and chain control. Internal control are measures within the organisational boundaries, the current AEO-framework focuses on internal control. Chain control goes beyond the organisational boundaries: the tallyman procedure described above is a good example of chain control. Risk acceptance is also a common practice following from the commercial rationale not to control, transfer or avoid risks but simply accept them. Doing business is entrepreneurship and includes working under a certain level of uncertainty, with corresponding risks taken for granted.

Key innovation drivers

What drives this innovation towards enahanced chain control? End-consumers not only demand lower prices, but also more efficient logistics, food and product safety, environment friendly production and logistics, and no child labour. This consumer demand is propagating through all the veins and leaves of the world-wide supply chains: Large retailers and food producers demand it from their suppliers, making it a value-added service for logistics service providers. This trend towards corporate social responsibility and need for transparency – driven by Internet and social media communication - means that companies can no longer get away with risk transfer policies, they have to take responsibility, even if they have transferred liability. As a consequence, it will accelerate the positive business cases for applying enhanced chain control. And if government agencies (more then just customs) broadly adopt supervision models based on chain control, predictability along the value chain will further increase and the business case will become even more positive. Chain control then becomes a necessity, primarily driven by value chain optimisation.

Relevant policy developments

The Cassandra research and innovation on the concept of the seamless integrated data pipeline contributes to higher awareness of supply chain owners on what they are paying for and shows them that increased visibility provides better (costs) management possibilities. Next Cassandra feeds fundamental customs policy issues that can stop the almost unlimited demand of data from the supply chain actors for fiscal, safety and security purposes. Providing trade the instruments and knowledge of better re-use and sharing of trade data, driven by commercial indicators, which at the same time can be used to automatically generate customs declarations, leads to possibilities to look in the source of data instead of only being satisfied with having those data. And providing customs the possibility to view even more data than strictly legally required in the dashboard, leads to better risk assessment and less administrative burdenes for trade. And sharing data within different authorisation levels, government stop to exchange datat amongst supply chain logistic partner, who for commercial reasons should never have these data.
And let's not forget that all these findings have been initiated by the SAFE Framework of Standards[3] of the World Customs Organization on the creation of smart & secure trade lanes. Furthermore, the Data Pipeline could be seen as a next step in world-wide Single Window

[3] (http://www.wcoomd.org/en/topics/facilitation/instrument-and-tools/tools/safe_package.aspx)

developments. Typically, most single windows are government systems where companies can electronically deliver all data required by border inspection agencies for the import or export of their goods.[4] The data pipeline extends the single window concept in the sense that (1) it crosses national boundaries, and (2) it provides the opportunity to all parties in the supply chain, companies and border inspection agencies alike, to share much more business control data than legally required[5].

CASSANDRA objectives

CASSANDRA's goals were to:

- Facilitating the adoption of a multi layered risk based approach towards supply chain security threads, on the basis of integral monitoring of data on cargo flows and container integrity, by showing its minimal impact on the trade transaction costs along the value chain and effectiveness in control and supervision
- Building visualisation dashboards in an open architecture, through interfaces between existing platform and visibility solutions
- Demonstrating the dashboards, underlying IT configurations and proof of concepts in three major trading routes to and from Europe, including a successful interaction with (US) authorities
- Evaluating the results from innovation developments in three Living Labs
- Facilitating a dialogue between business and government to gain consensus on the criteria for data sharing between business and government

The project participants cover relevant stakeholders, including freight forwarders, port authorities and terminal operators, port and business community system providers, other IT solution providers, border control agencies like customs and national police, and knowledge institutes. This report presents an integration of the key results and project conclusions.

[4] Single Window Planning and Implementation Guide, United Nations, Geneva, 2013. (http://www.unece.org/index.php?id=33853)

[5] Heijmann et all, THE DATA PIPELINE , Global Trade Facilitation Conference 2011 - Connecting International Trade: Single Windows and Supply Chains in the Next Decade.

2 Project results

Though the key concepts sound quite straightforward, their realisation is not. The legacy of 400 years' evolution of international trade, vested interests, reluctance to share data, lack of interoperability in data exchange, traditional supervision approaches, a traditional legislative framework with obsolete elements, and lack of multidisciplinary knowledge are just a few of the obstacles to overcome. This requires an innovative approach in a multi-stakeholder setting, using a real-life laboratory setting and creating an innovation environment that allows for experimenting beyond the existing boundaries and framework conditions. In CASSANDRA we call this a Living Lab approach. The project has provided tangible results that contribute to breaking down the obstacles identified above, like the data pipeline configurations and dashboards. Moreover, CASSANDRA also contributions to relevant policy developments, and results from this living lab approach: lessons learned, findings and insights into consequences and impacts and further specification of concepts like chain visibility and chain control, piggy backing, and chain-based supervision.

2.1 Global data pipeline and dashboards

The first key concept is the global data pipeline as an enabling infrastructure to achieve connectivity to accurate source data. CASSANDRA realised a pipeline architecture (D3.1) and within the different living labs developed several pipeline configurations based on integrating different existing IT systems, including business and port community systems already integrating parts of the chain data, economic actors' backoffice systems, and data captured by sensor technology, like container security devices (CSD). On top of that pipeline configuration, CASSANDRA also developed a range of dashboards that visualise the data according to the different users: different customs dashboards for authorities and business dashboards for commercial purposes were developed by different IT providers within the three Living Labs, thus stimulating internal competition among the developers in the consortium. For further details on the IT developments, please refer to the project deliverables in WP3, particularly D3.6.

Another aspect of the pipeline concept is the contribution to enhanced supply chain visibility. For that purpose, we developed the DASC methodology – Data Analysis in Supply Chains. This methodology, developed in one of the Living Labs, is used to make an inventory of the existing level of supply chain visibility by structuring the supply chain with events and linking references between different identification levels, like purchase order, shipment, consignment, container, vessel/vehicle, and corresponding statuses like customs status or commercial releases. DASC also identifies the corresponding data sources and missing elements and connections. A detailed description of the DASC methodology and its application can be found in Deliverable D4.1.

The work done in the project reconfirms the lack of reliable source data within the chain, and demonstrates ways to improve the often poor state of affairs. Links between purchase order, shipment and container are often lost downstream the value chain and detailed information during container stuffing is not always available on the same aggregation level in downstream processes, for instance on cargo details. Improving visibility using the data pipeline and the DASC methodology can have make a marked difference in data quality and reliability.

2.2 Living Lab approach

A key project result is the applied living lab methodology, which recognises that a data sharing ambition is hard to realise without strong stakeholder commitments, driven by voluntary collaboration. In the business-to–government application area, the evolution of value chains and corresponding information exchange practices have provided the basis for the current legal framework. Procedures like the submission of a pre-arrival declaration allow for complying to those requirements, and accepting the quality of secondary and often aggregated information.
In the business-to-business application area, the individual interests of the different stakeholders can be conflicting and have to be aligned. This is a well known and sensitive issue to overcome. Several stakeholders recognise the value of supply chain information to develop and adopt new value propositions. One of the key determinants is the power balance within the value chain that determines how and when data are being exchanged.

Most economic actors have considered the key business risks, including supply chain risks, and have considered possible ways to manage them: terminate or avoid, tolerate or accept, transfer, and treat or control risks. Only in some cases this has resulted in applying internal control and/or chain control mechanisms to treat those risks effectively. This choice often follows from commercial rationale. So there is not a tendency to aim for enhanced control, this is a business case consideration, sometimes done explicitly, sometimes done implicitly. Moreover, managing supply chain and business risks is not the same as managing customs risks: there are complementarities, but also conflicting objectives.

With a certain level of internal control, economic actors are considered trusted traders and therefore compliant. So as long as legal requirements do not become stricter, commercial actors might not feel urgency to adjust their mix of risk management approaches.

In this multi-stakeholder ecosystem, CASSANDRA has developed a methodology to address these challenges in a structured way and facilitate a process that accelerates the realisation of the innovation agenda. This process has been applied in the different living labs and the results are clearly described in the corresponding deliverables.

But the Living Lab methodology is more than just a process approach. It also includes two content-related instruments to support the engagement and convergence process in a multi-stakeholder setting: the DASC methodology for data analysis throughout the supply chain and a serious game that helps stakeholders understand and align each other's positions and strategies, the consequences of external and disturbing events and the impact of control measures. This game has been developed under the auspices of CASSSANDRA to support the innovation and adoption processes, and works as a catalyst for the underlying innovation agenda.

2.3 Chain based supervision

Today, the supervision model of border control agencies, like customs is still very focused on the entry and exit processes corresponding with the entry or exit of consignments subject to customs control regimes. Both customs organisations and economic actors have organised themselves accordingly. Recent developments, like mandatory pre-arrival declarations (the so-called Entry Summary Declaration (ENS)), the AEO-framework and the WCO SAFE Framework describing potential reuse of improved upstream controls (exit/export) have only marginally impacted this.

The development of the concept of piggy backing moved in the project into two directions. First, piggy backing on accurate source data has potential for better risk targeting and more efficient information gathering in transactions requiring more visibility. Customs recognise this

and consider strategies to realise better connectivity to this accurate source data. CASSANDRA has developed pragmatic solutions, for example, it enabled Dutch Customs to develop a procdure for importers for optional dual filing of additional information and ways to provide additional information in the free field in the ENS declaration protocol. The global data pipeline and corresponding dashboard development process helped identify specific challenges in realising this in a scalable way.

Second, CASSANDRA also further developed the concept of piggy backing on business controls. A concept that is already being applied within the AEO-framework, with a strong focus on recognition of the effectiveness of internal business control measures in managing customs risks. However, many vulnerabilities for customs risks go beyond the direct sphere of influence of individual chain actors and require chain control measures. As shown in CASSANDRA, validating data accuracy by the multiple-eyes auditing principle of comparing the same data elements from different sources along the value chain; examples of this are the tallyman at the container stuffing point to validate the packing list information of a container, or the three-way match done when goods are received by a company.[6] Companies that apply such chain control measures make first steps towards to qualify for chain based supervision models, like the Trusted Tradelane Model, further elaborated in Deliverable D6.3.

2.4 Policy development

CASSANDRA has positively contributed to policy development on several levels. CASSANDRA has illustrated the difficulty of transition management from concept development towards policy development. Concepts like the system based approach, joint risk management, data sharing architectures and new governnance models can be demonstrated and further explored, but the transition to full scale deployment requires implementing the right support policies in order to keep stakeholders engaged in the realisation of these agendas and convince them the envisaged benefits are achievable in a reasonable time frame. For this transition, detailed aspects of the implementation agenda need to be tackled upfront. CASSANDRA helped to identify such topics and explored solutions to overcome such obstacles.

On a global level, CASSANDRA initiated an elaboration of the trade facilitation and supply chain security policies of the World Customs Organisation (WCO). Driven by the need to ensure that WCO Members were well-positioned to meet the challenges and opportunities of the global trading environment, the WCO Council adopted its Customs in the 21st Century strategic vision in 2008. It comprises ten building blocks, of which Globally Networked Customs (GNC) is the first. To make GNC a reality, a Working Group was set up by the WCO to undertake “a comprehensive analysis of the potential to rationalize, harmonize and standardize the secure and efficient exchange of information between WCO Members”[7]. The global data pipeline architecture could also be applied to customs-to-customs information exchange. Moreover, the concept of piggy backing goes beyond the reuse potential of business and chain control measures to control customs risks. It also includes the potential for reusing risk assessment results and control interventions from other control agencies, who mutually recognise the value and effectiveness. This includes mutual recognition of AEO or similar certification schemes, but also exchanging of risk assessment outcomes. Such examples are a specification of the concept of Globally Networked Customs. The agenda to build further upon these CASSANDRA findings is addressed in the CORE project, in which

[6] Three-way match means that when goods are deliverd at the (1) warehouse of a company, they are checked against the purchase order at the (2) purchase department if the right goods were delivered, and the (3) finance deprtment if the purchas deprtment was authorised to order these goods.

[7] World Customs Organisation, Globally Networked Customs Concept, Strategic Value, 2012.

WCO is actively engaged in and specific demonstrations aimed at operationalise the concept of Globally Networked Customs (e.g. CORE WP 13).

Another level is that of the European Union. The CASSANDRA project started with the assumption that the current ENS-procedure to enhance supply chain security is ineffective, and with the statement that customs controls are often being executed on illogical and disturbing moments and places along the value chain. First of all, the dissemination events in CASSANDRA helped raise policy attention for these topics, and have contributed positively to recognition by European policy makers that this is a serious issue. By the end of 2012, DG TAXUD recognised this and identifies the same pitfalls in its Communication on Customs Risk Management, COM(2012)793. Secondly, the policy discussion on dual or multiple filing of the ENS has been supported by CASSANDRA. One of the CASSANDRA use cases has shown that this can be supported by the data pipeline concept, while the evaluation has shown that optional dual filing can contribute to Customs'application of the trusted tradelane concept. Thirdly, the steps that have been taken in the Blue Belt Policy to facilitate the internal market of shortsea shipping in Europe, by applying a harmonised eManifest information exchange procedure in combination with the trusted trader concept, allowed for expanding that concept to shortsea roundtrips including both EU-ports and non-EU ports. As such, the Blue Belt outcome is a clear example of the combination of data exchange protocols in combination with a trustworthiness concept - the essence of the CASSANDRA concept.

A third policy influencing level is the national level. The most obvious example is the development of the new Dutch customs *Enforcement Vision*, which is clearly fed by the discussions, findings and insights developed in CASSANDRA. This is confirmed by the exploitation plan of Dutch customs in Deliverable D7.5. The results of D2.3 and D6.3 clearly describe the need for expanding the trusted trader concept to that of trusted tradelanes and a corresponding chain control framework to operationalise such a concept. Furthermore, the data pipeline architecture was also input for developing national Single Window environments, not only for eCustoms but also in the frame of complying with the Ship Reporting Facility Directive (Directive 2010/65/EU). In the Netherlands for instance, the data pipeline architecture was included in the design principles for developing a robust Neutral Logistics Information Platform (NLIP), meaning that NLIP could function as a 'landing place' for the Data Pipeline for trade volumes crossing Dutch Territory. Deliverable D3.6 and a number of scientific publications provide more detail on this.

3 Findings and lessons learned

3.1 General findings

The evolution of supply chain risk management portfolio
The way economic actors deal with supply chain risks - the four SCRM approaches (avoid/terminate, transfer, accept/tolerate and treat/control) - is driven by economic rationale. Risk transfer has evolved over the years as an effective instrument to cope with corresponding commercial risks. Globalisation and specialisation have led to fragmentation of value chain processes. Insurance concepts aligned with the global liability regimes and service level agreements have allowed for far reaching outsourcing strategies which have proven to be highly effective and efficient for global trade. And when actively applying control mechanisms is considered, it mainly deals with internal control measures. Chain control measures are not widely applied, other risk portfolio measures prevail. This is often because they are expected to be more efficient (true or not true) or due to lack of capabilities to apply chain control measures effectively.

Huge differences in maturity levels of supply chain risk management
The analysis of the way businesses apply supply chain risk management shows a great variety in the way this is being done, ranging from highly sophisticated methods with great levels of detail, to implicit considerations and pragmatic choices in day-to-day decisions. The potential for piggy backing on these control measures requires a certain level of structured reporting of this process and making options and choices explicit.

Strategic value of data and reluctance to share
Data are valuable and many actors along the value chain recognise this. Almost all of them consider new value propositions based on enhanced chain visibility. As such, they want to position themselves for this service proposition and are reluctant to share their valuable data with other actors who might have similar strategies. A good example are the different models for chain coordination: carrier haulage, merchant haulage and terminal haulage, where respectively ocean carriers, global freight forwarders and terminal operators see themselves as coordinator of the transportation chain.

Need for multidisciplinary knowledge
CASSANDRA integrates supply chain knowledge, thorough understanding of the legislative framework of international trade and knowledge of IT innovations. SME's need people who possess such multidisciplinary capabilities, who also tend to be faily rare. Within larger organisations, the multidisciplinary knowledge and capabilities are often spread across different departments, each with their own objectives, incentive systems and decision making powers. This makes it difficult to effectively engage the decision making units within the larger organisations.

3.2 Living lab findings

The living lab approach applied in CASSANDRA has also highlighted relevant findings and critical success factors in realising complex multi-stakeholder innovations. The most striking ones are summarised below.

Agreeing on the proper scope and level of ambition

In developing and demonstrating innovative concepts it is important to keep in mind that there is a reason that these innovations have not been fully implemented yet. Reasons can include the lack of a comprehensive business case for the solutions, lack of feeling the sense of urgency, experiencing too wide a gap between current maturity levels, discrepancy between what a demonstration team should do and what it can do, and a lack of clear and common ambitions. The risk of enlarging the demonstration scope should be properly identified and managed.

Having the right stakeholders involved
Decisions that have a large influence on the demonstration outcome are preferably made inside the consortium, but the decision to include a particular trade lane in the Cassandra demonstration could only be made outside the consortium. The logistics industry partners in CASSANDRA were logistics service providers, either forwarding organisations or (de)consolidators, no shippers or importers. It was assumed that they would represent the stakes of the shippers and importers, their customers. But logistics service providers are often not the owners of the supply chain and the goods, and therefore it was not their final decision to include a particular trade lane in the Cassandra demonstration. The decision was to be made by their customers and the owners of the cargo shipped in the chains: the shippers. For some trade lanes the approval by the shippers to reuse their data became a serious bottleneck. Engagement of cargo owners and shippers is therefore crucial. During the project, we managed to engage shippers to ‘play their role’, consequently the European Shippers’ Council will coordinate the follow up project CORE.

Understanding strategic stakeholder agenda
Global freight forwarders have supply chain visibility strategies with value propositions for their customers based upon this visibility. It is questionable whether or not the distributed and open data pipeline architecture of CASSANDRA is the right delivery mechanism for realising such value propositions, as these freight forwarders might have an aim to ‘internalise’ the global data pipeline concept. Another sensitive aspect is the ‘battle for chain coordination’ between carrier haulage and merchant haulage services. Carrier haulage is when the shipping company itself takes care of preliminary and subsequent transport of a container. Merchant’s haulage is when the preliminary and subsequent transport is carried out by the shipper and the receiver of a container respectively, often being outsourced to a freight forwarding company. It is obvious that enhanced chain visibility helps in better offering such chain coordination value propositions. As a consequens, supply chain actors considering this role – including freight forwarders - want to distinguish themselves from other chain actors, thus reluctant to share data.

Trust
In a large demonstration such as a Cassandra Living Lab it is important to create the right level of trust needed to showcase the ambition. There was close collaboration between pipeline IT providers and Customs dashboard IT providers in designing the interfaces between the two. There was also close collaboration between pipeline providers and their clients (industry partners, i.e. importers who provide the data for the pipeline). However, these industry partners were not actively engaged in the design of the Customs dashboard, as they were indirect stakeholders rather than direct stakeholders (in this context, "direct" means system users or owners of interfacing systems). Yet industry partners are the owners of the data in the systems of the pipeline providers. Because of their limited involvement, the industry partners were not sufficiently aware of the developments in the Customs dashboard, which negatively affected their level of trust in what would happen to their data once they were made available to the Customs dashboard, which negatively affected the data quality there. Consequently, some (highly) sensitive data were cloaked in the pipeline and therefore

also in the Customs dashboard. Although this did not affect the technical proof of concept of the solution, it did influence the user experience, especially for the users of the Customs dashboard. An important lesson learned for the future is thus to engage a broader group of stakeholders than strictly needed in solution design and put even more focus on building trust.

3.3 Findings from IT development

IT components in the post Cassandra stage

In the Cassandra project, IT development is focused on the support of the Living Labs in providing upstream data to customs. In this respect, three components have been developed, complemented by an additional component:

- Customs Dashboards
  These supply chain visibility dashboards provide additional data to customs authority for risk assessment. A customs risk officer is able to retrieve additional data, in addition to the mandatory data provided by companies in the ENS and the customs declaration, to improve the risk assessment of imported and exported goods. DCA and HMRC have validated the functionality. HMRC expected that all data required for risk assessment would be pushed to the dashboard, but this completeness could not be realized in the limited time period of CASSANDRA. Additionally, customs dashboards have been developed for Spanish and Portuguese customs, which are however not validated in practical settings.
- Pipeline Endpoints
  A Pipeline Endpoint is the IT system at which all data of a trade lane is available to customs. Descartes and GS1 Hong Kong provided two Pipeline Endpoints in practical settings; Portic and Setubal Port Authority interface as potential Pipeline Endpoints to the Spanish and Portuguese customs dashboard.
- Interface specifications
  Interfaces for data sharing between a Pipeline Endpoint and a customs dashboard are based on UN/CEFACT message structures, the IFTMCS. Data requirements formulated by customs authorities and semantically modeled by an ontology have been mapped to this message. The same data requirements can be implemented by the WCO GOVCBR message standard, which is a requirement of HMRC. Implementations of the interface differ for each customs dashboard, which makes them incompatible. There is a facility constructed by Atos Research and GMV to share data between the Spanish and Portuguese Pipeline Endpoint and both customs dashboards, but the latter dashboard cannot interface with Descartes and GS1.
- Business dashboard
  Descartes and GS1 Hong Kong have constructed a business dashboard. The GS1 dashboard is based on the EPCIS standard and applied in the Seacon trade lane. The Descartes business dashboard is constructed on top of the Descartes Global Logistics Network (GLN) for data sharing and –transformation services amongst traders. As such, the Descartes business dashboard can serve as a generic supply chain visibility platform for those traders and trade lanes that utilize GLN for data sharing.

Requirements for extending Cassandra implementation

Extending Cassandra implementation to more trade lanes and including additional Pipeline Endpoints, means that particular requirements need to be met. Data quality needs to increase by electronic data sharing amongst traders.

Data quality[8] is expressed as:

- **Data volatility**: data representing the actual physical situation is (almost) immediately available. Visibility solutions and dashboards support this functionality by extracting data from different sources.
- **Data completeness** by having all trade lane data electronically available including that of a Consignment Completion Point.
- **Data consistency** meaning that all stakeholders in a trade lane operate with identical data.
- **Data correctness** meaning that the data represents the actual contents of packages, containers, etc.

Trader interoperability contributes to data completeness, - consistency, and – correctness. Thus, the main requirement is trader interoperability at a global scale and all solutions to the other requirements have to contribute to trader interoperability. The following table lists these requirements and shows how they can be implemented (see Cassandra D3.6 for more details).

Data pipeline requirements	Corresponding solution
Liability: visibility increases carrier's liability	**Cassandra Security Architecture** (Cassandra Deliverable D3.3): restrict party access to the data of another party in the Cassandra Pipeline based on distributed identity schemes and access policies, so that carriers can continue to avoid legal responsibility and each actor is able to access his particular data
Commercially sensitive data: visibility requires sharing of commercial sensitive data	**Data governance**: each stakeholder is in control of its data by specifying access policies, whereas authorities are able to enforce their access policies upon traders. Of course, traders can only contribute data they have from their business perspective
Upstream data access: how to access upstream data.	**Endpoint**: a trader provides an endpoint at which authorities can retrieve data. The endpoint can have all data of a particular trade lane ('**Pipeline Endpoint**') or all data of a trader acting in one or more trade lanes ('**Trader Endpoint**')
Legal prohibited data exchange: sharing of data between Authorities is not allowed	**Endpoint**: the Cassandra Pipeline provides data from the source via an endpoint to multiple partners and authorities downstream in supply chains which diminishes the need for data exchange between different Authorities (e.g. customs, food- and product safety inspection, dual-use inspection etc.)
(Open) standards: different implementation guides for Business-to-Business (B2B) and Business-to-Government (B2G) interoperability in supply - and logistics chains	**Seamless interoperability**: piggy backing on trader data requires transformation configured by common semantics between logistic standards and standards of authorities

The WCO data model, its declaration based structure, its specific modelling technology that is not based on existing (open) standards and technologies like UML (Unified Modeling

[8] Batini, Carlo; Scannapieco, Monica, Data quality: concepts, methodologies, and techniques, Springer-Verlag, 2006.

Language) or OWL (Ontology Web Language), its (implicit) method for developing implementation guides, and the lock in of a tool provider do not lead to an open system. Models and guides can only be shared electronically amongst those that use the same tool; there is not a clear and concise meta model like the one of for instance OWL.

Customs access policies, implemented by these national guides based on the WCO approach, will still differ. The differences between national guides are difficult for a trader to assess and potentially lead to higher investments of traders interfacing with different customs authorities.

Requirement for a Customs Policy
Although a number of IT Services and Solutions are developed to implement the data pipeline, the exploitation and dissemination plan (Cassandra D7.5) learns that IT Service and – Solution Providers will not invest in Cassandra (**technology push**), unless there is a market pull from either authorities and/or business sector. From the start of the project, a **market pull** for upstream data by the business sector has been expected. The Living Labs should lead to **positive business cases** as the basis for such a market pull, leading to IT investments by business and thus IT Services and – Solutions supporting the data pipeline.

Only positive business cases are not sufficient for realizing the data pipeline. A **customs policy** with respect to piggy backing on these business cases is required. Basic questions as to where data is stored considering access policies and security, how it will be accessed (see the above mentioned solutions), and who will provide the data, e.g. shippers, logistic service providers, carriers, or do they all provide their part of the data need to be addressed. The latter question is relevant as to who will be responsible for increasing the quality of trade lane data.
Furthermore, the so-called business-government ineraction protocols (Cassandra D2.3) need to be clearly specified from an IT perspective, in relation to AEO classifications provided by EU regulations and their national implementations (see also Cassandra D2.3). Customs feedback to data provision needs to be clear, e.g. does a trader receive notification that there will be no inspections of a particular shipment. This feedback affects trader decisions with respect to transport choices and enables concepts like synchromodality.

The Cassandra IT vision (Cassandra D3.6) assumes particular answers to these questions, like all traders provide their part of the data and trader data is accessible by customs authorities (piggy backing on trader data) leading to a decrease of the administrative burden.

4 Impact & stakeholder benefits

The CASSANDRA concepts have been operationalized by applying 14 use cases, subject to economic analysis, of which a subset was demonstrated in the Living Labs. These 14 use cases have been clustered into four categories: data quality, exception reporting (reactive data use), advanced notification (proactive data use) and data reuse by other chain actors.

Key commercial benefits linked to the 'control interventions' have been grouped into two categories:

- Efficiency gains contributing to reduced landed costs[9].
- New value propositions enabled by enhanced supply chain control

The next sections highlight these benefits. In addition, the chapter closes with a brief outline of the contribution to more effective control and supervision by border control agencies.

4.1 Landed cost reductions from chain control interventions

Two examples of chain control interventions have been demonstrated and analysed: the three-way match and the introduction of a tallyman at the point of container stuffing. Both examples are validating the accuracy of data being used for planning downstream activities. The three-way match is a widely used practice in many push-based production and distribution channels aimed at controlling the risk of discrepancies between order, delivery and payment. This is often validated downstream the value chain and thus too late for customs to control certain 'stop-risks'. Whereas the three-way match compares data from different sources, an alternative way is to check the data against reality already upstream during consolidation or stuffing by means of a tallyman. The key benefits associated with these control measures include:

- **Operate according to designed supply chain channels**

The distinctive design of supply chains for full container loads (FCL) and less than container loads (LCL), where LCL-shipments undergo consolidation before executing the main transport haul, is a common practice resulting in highly efficient and sustainable use of transportation networks. However, these channels not always function according to the design principles, resulting in excessive high landed costs for the buyer, the true consignee. The EU-China tradelane in CASSANDRA highlighted this. The assignment rule was based on volumetric thresholds following from the packing list. When stripping containers from China in the port of destination, considerable discrepancies with the packing list became apparent. Also, some consignors used unnecessarily large or high boxes, partly filled with free space to reach the threshold for FCL-treatment. The tallyman was introduced, in combination with a machine for automatic measurement of box dimensions, to control this effectively, resulting in a reduction of inaccurate packing list information from over 10% to less than 1% of the consignments.

- **Enable supply chain redesigns – destination-based stuffing and cross-docking**

Enhanced chain control measures like the tallyman allows for supply chain redesign. Enhanced predictability allows for destination-based stuffing and cross-docking in the port of destination, instead of deconsolidation, warehousing, picking and distribution towards regional warehouses or customers. This major step requires farfetched predictability, and is now under consideration in one of the tradelanes. Also the true LCL volumes on a tradelane may appear

[9] Landed Cost is the total cost of a product once it has arrived at the buyer's door, including the original cost of the item, all brokerage and logistics fees, complete shipping costs, customs duties, tariffs, taxes, insurance, currency conversion, crating costs, and handling fees.

to be much larger than expected, justifying investments in larger consolidation centres, thus contributing to economies of scale.

- **Efficiency in warehousing activities**

For one of the freight forwarders also involved in warehousing processes, warehouse handling cost reduction was realised through improved packing and container stuffing. An issue identified in the Living Lab approach was the use of unnecessary large boxes during packing, with the purpose of allowing for treatment of the container in the FCL channel (generally faster lead times). This unwanted practice resulted in empty space in the boxes, thus causing damage when stacking the boxes on top of each other.

Through the use of a tallyman and by validating the weights and dimensions of container contents with the help of digitally scanning devices this practice could be avoided. That allows for improved container stuffing, which leads to reduced handling effort, increased warehouse performance and also better data quality. The savings identified correspond to a reduction of about € 50.000 per year in handling costs for a relatively small freight forwarder with a throughput of 150 containers/ week, corresponding to a reduction of 11.6%. The potential savings per container in total handling expenses equals €6.40 per container.

Moreover, the improvement of warehousing revenue is significant. Currently the stack height in the warehouse is 2.5 pallets on average. By assuming that packing optimization can raise the average stack height to 2.8 pallets, the extra space can be used to serve new customers, resulting in 9.6% increase in warehousing revenue corresponding to additional revenues of €250.000 per year.

4.2 New value propositions

The CASSANDRA exploitation plan (D7.5) identifies a whole range of value propositions being considered for further exploration and exploitation by CASSANDRA consortium partners, some of them have regularly popped up in the Living Lab approach and are worth highlighting.

First there is the service of digitising manual source data at the point of stuffing or consolidation for reuse purposes. Particularly in the ‘first mile’ of end-to-end supply chains we find many factories lacking the capabilities to capture data in a digital way. Paper-based order and transport documents are still common practise. Here, the freight consolidation centres could play a valuable role in digitising this information and providing connectivity to data pipeline infrastructures. This function could be offered as a service by operators of such freight consolidation centres, often freight forwarders. They can also help deploy connectivity tooling at these ‘first mile’ factories and supplier networks.

Second, the chain controls and validation processes (e.g. electronic version of a tallyman) can be offered as a value added service proposition. This could be restricted to just implementing a certain control measure and sharing the outcomes of that control measure with other chain partners. But it could also be part of a broader service proposition to identify weaknesses in the chain of custody and implement correspondingly the most effective and cost efficient chain control measures.

Third, we observe a consolidation in the market for duty management solution providers and supply chain visibility providers, resulting in a limited number of key providers to integrate these two functional areas. CASSANDRA partners such as Descartes or IBM are some examples of these. Landed cost reduction potential is often a crucial part of the business case

for implementing this integrated functionality. Border control interventions are often assumed as a given in landed cost calculations. More sophisticated landed cost calculations taking into account the impact of alternative control interventions would not only strengthen the functional portfolio of these solution providers, but also help convince users to buy their software.

4.3 More effective customs control

Since the security amendments to the Customs Code, national customs authorities in Europe have to perform pre-arrival risk assessment. The basis for that assessment is the pre-arrival declaration, the Entry Summary Declaration (ENS). The current risk engines identify too many transactions as 'orange', e.g. too many false-positives, requiring excessive numbers of further analysis and/or requesting additional information sources. This false-positive problem is partly due to inaccurate or insufficient data. Below, we identify some areas of enhanced customs visibility.

- **Construct chain of actors**

The data pipeline links different commercial transactions thus allowing the construction of a chain of actors involved in the value chain of a commercial trade transaction. This is also valuable for customs. Customs currently uses a time consuming manual pull-based way, primarily via phone calls, to build up a complete picture of the involved actors along the value chain. Particularly, the true consignor and consignee have to be constructed by comparing standard customs declarations (pre-arrival, import, transit) with commercial transactions like invoice, packing list, manifest, bill of lading etc. The DASC-methodology applied in the business dashboard allows for creating this type of visibility. The voluntary sharing of the business dashboard functionality to customs users is one way to overcome this. Another way is to allow for optional dual filing of alternative information of true consignee/consignor identifiers in pre-arrival declarations, eventually fed by the data pipeline.

- **Link actor visibility with trustworthiness databases**

The customs dashboard functionality allows for interfaces between the actors identified and the information on trustworthiness of actors from other databases. Examples include databases to relevant certification programmes like AEO, CT-PAT, TAPA, ISO, Known Consignor/Regulated Agent, but also to trustworthiness databases from commercial providers like Dun&Bradstreet. The Customs dashboard has demonstrated a working interface with Dun&Bradstreet, by linking the actor identification with DUNS-numbers and visualising a selection of the corresponding trustworthiness data. This concept can be further developed.

- **Visualise the source of the data in the customs dashboard**

The data pipeline and corresponding customs dashboard allow for visualising the source of the data elements in the dashboard views. This can help decision makers assess the expected quality of the data submitted. For instance, if the declared quantity of goods items included in an import declaration may originate from a validated packing list or from a ship manifest, this could impact the perceived data quality. Also the customs value of the declared goods may originate from a commercial invoice, or from a purchase order. This also matters.

- **Piggy back on the commercial control mechanisms**

Identifying trusted tradelanes would be a way to apply tailor-made control and supervision models. This means customs needs to be able to identify and assess them. Therefore, tradelane partners need to expose the control measures they apply. The current AEO-framework does not fully cover this scope.The concept of trusted tradelanes needs to be further operationalised. Obviously, chain control measures like the tallyman, the three-way data consistency match, partner screening procedures and container integrity applications are

part of such a framework. The first steps in operationalising such a trusted tradelane concept have been taken and reported upon in Deliverables D2.3 and more particularly D6.3.

5 The innovation roadmap – CASSANDRISE ME

5.1 CASSANDRA Innovation roadmap

CASSANDRA has proven that the key concepts of reuse of reliable source data and integrate government control better into the supply chain make sense, but are hard to realize and in some cases require further operationalisation. The further operationalision of the concept of chain based supervision through trusted tradelanes is such an example. But even more important, full scale deployment of the key concepts requires an integrated innovation development approach along different dimensions:

- Technology; First, there is the IT roadmap to support widespread deployment of global data pipeline configurations and standardized interfaces for customs and business purposes. The next section describes this roadmap in more detail. Then, there is the integration of all kinds of security technologies in a multi-layered approach that balances supply chain security, trade facilitation and commercial benefits for individual companies. This includes also aspects like integration of scanning lanes, the business model of container security devices, and feasibility of composite constainers, just to mention a few. CASSANDRA has not covered this broad multi-layered approach, but CORE will.

- Key stakeholder engagement; First, one of the findings was the lack of direct and proactive shipper and importer involvement in CASSANDRA. The same applies to ocean carriers, that perform a crucial part of the transportation and value chain and fulfil a key role in full scale realisation of the concepts. The follow-up step is taken in the CORE project, which is being coordinated by the European Shippers'Council and includes active engagement and involvement of shippers, like Procter & Gamble, General Motors and Flora Holland, and ocean carriers like Maersk Line.

- Knowledge agenda and supply chain thinking; Realising chain control and chain based supervision requires border control agencies to better understand logistics and supply chain management and also understand how their supervision role interferes with supply chian optimization. This implies for some customs orgainsations a paradigm shift. The serious game developed under auspicien of CASSANDRA and the education material developed in the frame of CASSANDRA for the Master Programme on Customs and Supply Chain Compliance[10] help in further adopting this way of thinking. And the relevance of this multidisciplinary knowledge agenda is not limited to control and supervision agencies, many large organisations have organized themselves along fragmented departments, also resulting in underuilisation ogf the potential of integrwating these knowledge areas even within the boundaries of the individual organization.

- Support policies; The realization of this innovation agenda will not happen without strong support policies, both on global, European and national levels. The follow up project CORE mobilises active engagement and involvement of World Customs Organisation, INTERPOL, The International Road Union (IRU), the different European policy DG's (TAXUD, ENTR, MOVE), the US Department of Homeland Security, national customs organisations and other border control agencies like Royal National Police and food safety inspection agencies offer better potential for alignment with their policy programmes.

[10] This is a joint initiative of the Rotterdam School of Management, TU Delft, TU Eindhoven and TNO. See WWW.RSM.NL/CUSTOMS

External developments, like the multilateral trade agreement between the EU and the USA or the increased attention towards Corporate Social Responsibility can raise the urgency and accelerate the adoption of the key CASSANDRA concepts.

5.2 The IT innovation roadmap

The basic IT innovation is a paradigm shift from the messaging - ('push' and duplication of data) to the resource oriented paradigm ('pull' of data from a resource) by implementing data – and process mining technology for authorities, seamless interoperability for traders, and separating access policies from data sharing technology:

- **Data – and process mining**. Data mining is a business intelligence method that considers the goods, containers, transport means, etc., their associations like the goods packed in a box, and all relevant (historic) trader data like their Duns & Bradstreet information demonstrated in the Living Labs. Process mining considers the stakeholders involved in logistic chains and their relations, as can be monitored by accessing their data sharing logs and audit trails.

- **Seamless interoperability**. Traders publish their information profiles based on logistic services and locally connect these to their back office systems via an endpoint accessible to customs and implementing B2B interoperability. The endpoint can provide functionality like transformation between different standards and implementation guides.

- **Access policies**. Currently, message implementation guides, expressed in a syntax like EDI (e.g. GOVCBR or IFTM** messages) and XML represent access policies. The resource oriented paradigm separates access policies from the data sharing syntax, making it far more easier to change policies. These policies are a parameter for providing data to relevant stakeholders.

Depending on the business-government interaction protocol, the risk analysis results will be available to business either by pushing status information or making the status accessible to traders.

This IT innovation requires an IT roadmap and an IT action plan considering the earlier mentioned customs policy.

The following table lists the **IT Roadmap** with a time frame of 10-15 years; details of the roadmap can be found in the IT white paper (Cassandra D3.6).

Phase	Name	Description	Components
Phase 1	Post Cassandra situation	A basic infrastructure of a limited number of **pipeline endpoints** to support controlled experiments	Pipeline Endpoints Visibility dashboards for customs and business
Phase 2	Backbone Infrastructure	Upstream data retrieval to easily implemented additional controlled experiments based on **pipeline endpoints** with standard interfaces to dashboards and addressing **data governance** and **security**	Semantic model Access profile Data Governance Dashboard Trader Registry Certification Registry

			National Gateway(s)
Phase 3	Trader Interoperability	Piggy backing on trader data with improved quality and completeness by implementing **seamless interoperability**.	Trader Profile Interoperability Managing Tool Trader Connection Configuration Trader Endpoint
Phase 4	Secure Trade Based on Smart Risk Analysis	Risk analysis by **monitoring** complete and high quality data shared amongst traders.	Upgrade of Visibility Dashboard(s) Upgrade Trader – and Pipeline Endpoint Access policy update

Phase 2 prepares for phase 3 by experimenting with IT components in the CORE and potentially other future EU funded (Horizon2020) projects. A bottom-up approach will be taken by providing endpoints with transformation functionality configured by the semantic model. Eventually, phase 3 is the basis for phase 4.

On the one hand, an **IT Action Plan** further addresses basic research aspects, including practical experiments in Living Labs like in EU FP7 CORE, whereas on the other hand the customs policy needs to be elaborated further. **Basic research** considers bottom up semantic interoperability and large scale implementation of trader interoperability. These need to be validated in **Living Labs**, including further elaboration of data governance with various interventions to address liability and commercial sensitivity requirements. To elaborate **customs policy**, various aspects need to be studied with respect to the proposed Cassandra IT innovations like its legal feasibility and impact on procedures, IT systems, and finance. Such a study also needs to address the feasibility of implementation of these IT innovations by business and support by IT Service – and Solution providers.

6 Conclusion

Living labs have shown proof of concept that the Global Data Pipeline can be implemented. This does not require a big bang world-wide implementation, but it can be implemented in small realistic steps:

- Make inter-connections between exisiting IT systems in supply chains parties already in use (see the EU-China tradelane case)
- Most companies have IT systems that are quite consistent with dominant de facto trade data and customs data standards such as WCO datamodel V3, UN/CEFACT, GS1 etc
- De-facto standards WCO datamodel V3, UN/CEFACT, GS1 etc seem to converge well

The future direction of Global Data Pipeline development evolves in more generic interoperability via development of logistics ontology.

The Living Labs have shown proof of concept that Piggy-Back can work (e.g. re-use of business control data for government control purposes). The validated packing list data by a tallyman in the EU-China tradelane case can be re-used by customs to do better risk assessment, because it provides them access to more accurate data from the source. And optional dual filing in the customs dashboard gives Dutch Customs access to all kind of additional data from real source and provides a basis for better risk assessment.

CASSANDRA also has shown strong commercial rationales for investing in business-driven control improvement. Better controls in the EU-China tradelane case were done for improving supply chain predictability on request of retailer, not to please customs.

CASSANDRA has also highlighted some limitations. We have made less source data available for customs than we had hoped for. More source data is expected to be made available in CORE by actively engaging shippers. Another finding was that getting access via the Data Pipeline to business control data from freight forwarder and carrier appeared more difficult than expected, for several reasons, including:

- Technical reasons; Large freight forwarders have very costly world-wide IT systems, and many of them are now in costly upgrade transformation, which leads to very high operational IT costs right now. Maintenance costs of these IT systems are typically in the order of 100M per year. We expect a window of opportunity for data pipeline innovations among global freight forwarders after current IT upgrade transformations have been stabilised.

- Commercial reasons; Parties are concerned that their competitors see their commercially-sensitive data, both on horizontal competition (e.g. freight forwarders and carriers) and on vertical competition (e.g. between freight forwarders). Problems caused by these commercial reasons can be solved by extending the Data Pipeline with data access protocols that assure parties in the supply chain that they have IT tools to control which other party in the supply chain can access their data. Such data access protocols will be further developed in CORE.

As such, the CORE project is the next milestone in realising the key CASANDRA concepts. This poses a huge challenge, but also offers a perfect opportunity to make huge impact with applied research and technical development in the field of supply chain security. Will CORE CASSANDRISE us?