Smart containers: Quantifying the potential impact

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Abstract: *Never before the world was more dependent on transport processes than now. Although supply chain methods and technologies continuously improve, transporting goods is still not without risks. We observe two main challenges. On the one hand, depending on the type of goods, possible theft and deterioration of the products result in additional costs and hurdles. On the other hand, operations and processes can also be significantly impacted by delayed or deficient transport processes. Examples are the time-susceptibility of just-in-time (JIT) processes or the value decrease of late arriving seasonal goods such as the gifts for Christmas, etc. Furthermore, more and more international organizations and governments (e.g. World Customs Organizations, the U.S. Customs Trade Partnership against Terrorism (C-TPAT) and Europe's new Authorized Economic Operator (AEO) program [1]) require so called secured lanes, which foresee in end-to-end security].*

Containers provided with monitoring technology could tackle many of the current transport issues. Smart containers, as they are called, can not only provide real-time location information, but depending on the technologies installed they can monitor context parameters such as door opening activities, temperature, humidity, acceleration, air flow, gas detection, etc. On top of that, most intelligent containers can detect what their cargo is, if everything is in it, if the doors are opened by an authorized person, if the container is located at the right place, etc. [1].

The main questions are: 1) what are the issues to overcome to create a sustainable business case for all actors involved, and 2) whether the investment in smart containers leads to positive returns.

Keywords: *smart container, value network analysis, impact quantification, smart transport*

I. Introduction

a. Smart monitoring technologies

Smart container monitoring services is a general term for real time tracking and monitoring the location and condition of goods during the transportation process. Installing sensors in the freight container allow monitoring the temperature, humidity, gas concentration, acceleration, door activities and location. Based on these parameters alerts can be triggered when deviations are noticed.

In general, container monitoring services consists of three pillars (figure 1):

- **A Client Dashboard** allows the client to track the assets, set alarms, monitor the cargo conditions, etc.

- **A central platform** to manage the equipment installed in the containers, and to manage the roles of the various involved actors.
- **Container monitoring device**, which is a piece of hardware installed in the container in a fixed or removable manner. Typically the hardware consists of 1) sensors to monitor the environment (temp, humidity, gas sensors, accelerometer, door sensor, etc.), 2) GPS-unit for location tracking, 3) communication module (GSM, GPRS, Satellite or newer LPWAN technologies such as Sigfox), and 4) a long-lasting battery pack.

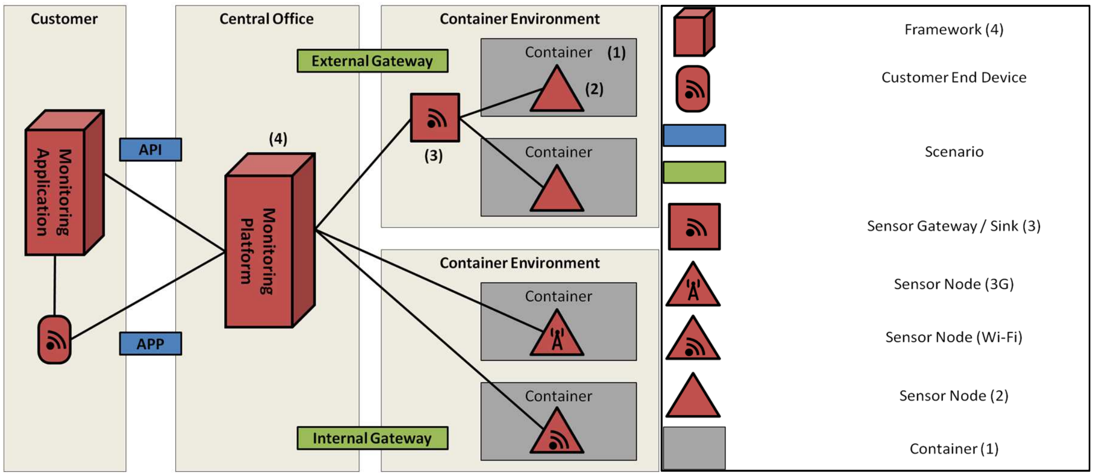

Figure 1: Typical framework of container monitoring services

b. Transportation process

In order to quantify the added value of smart containers, a good understanding of the transportation industry and processes is needed. And more specifically, how smart containers tackle current issues and challenges of transporting goods.

In essence overseas transport processes consist of seven different process steps. This can be seen in Figure 2 below (process based on [2]).

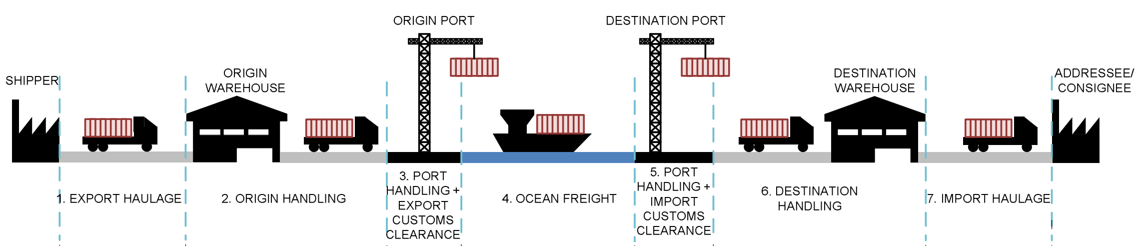

Figure 2: Simplified overview of a transport process

Table 1 provides an overview of the main process steps for transporting goods.

Table 1: brief description of the transport process blocks

Process step	Description
1. *Export Haulage*	Transporting the goods to the origin warehouse of freight forwarder
2. *Origin Handling*	All cargo handling tasks at the origin warehouse: - Checking cargo validating it against the booking details. - Consolidation and aggregation with other cargo according to their destination, volume, transport method, priority, etc. - Container loading - Transportation of container to the port of origin - Container grouping according to the loading scheme of the vessel.
3. *Export Customs Clearance*	Official registration of cargo by local authorities of the country of origin. Export documents list cargo details and other officially needed information. Depending on the cargo and its country of destination the cargo can be subjected to inspection.
4. *Ocean Freight*	Overseas transport provided by shipping line
5. *Import Customs Clearance*	Before the cargo enters the country, thus before it crossed a country border and left a customs bonded area, the import customs clearance process should be completed. This process step can be done by the freight forwarder, his agent or a nominated customs house broker whenever the actor holds a valid license. The import customs clearance is a set of documents needed for all cargo entering the country. These documents describe the type of goods and its characteristics which are needed for the customs authorities and the tax authorities of the country. Depending on the type of cargo, the sender and other parameters, local customs authorities could scan and inspect the incoming goods.
6. *Destination Handling*	After successful customs clearance, the container will be transported to the destination warehouse of the freight forwarder. There the cargo will be controlled and checked again on completeness. The consolidated container will be un-stuffed and cargo will be sorted and regrouped again for onward transportation or stored for collection by the consignee.
7. *Import Haulage*	Transport from the destination warehouse to the consignee. This step could be performed by the consignee who comes to the destination warehouse to collect the cargo or it can be performed by the freight forwarder as well. In the latter case, often it happens that the freight forwarder optimizes truck or train loads which could result in a less optimal multi hub journey of the cargo.

These process steps and required roles can be fulfilled by many different actors. Figure 3 provides a simplified version of the value network. This is a set of interlinked roles needed for delivering overseas transport services. These roles are inseparable business activities and provide each other value (indicated by an arrow).

An actor (persons, organizations or corporations) is responsible for one or more roles in the value network. Mapping the actors onto the roles gives insight in: 1) Who does what, and 2) what type of values do actors exchange with each other?

Tables 2 and 3 describe the different roles and actors respectively.

Table 2: Description of the roles in a transport value network

Role	Description
Actor that wants to transport the goods	Having the need to transport goods
Logistic service provisioning	Coordinating the complete logistic process, for the client you are the single point of contact for the complete transportation process
Cargo transporting/ shipping	Transporting the goods by means of trucks, plane, rails or ships
Cargo origin handling	Providing warehousing facilities at the place of origin and consolidating cargo in order to fill up containers based on their similar transport characteristics.
Cargo destination handling	Providing warehousing facilities at the place of destination and consolidating cargo in order to fill up containers based on their similar transport characteristics.
Cargo insurance provisioning	Offering cargo insurances to the owner of the goods
Cargo port handling	Cargo needs to be loaded, unloaded, and moved around the harbour, on ships and on trucks. This is a task of the port. (also known as Terminal handling TH)
Container leasing and maintaining	Offering container leasing and maintaining services.
Customs service provisioning	Providing customs service [3]

All these roles need to be taken up by one or more actors in order to be able to complete the transportation process. Table 3 presents the actors involved in the transportation process.

Table 3: Description of the actors in a transport value network

Actor	Description
Shipper or cargo owner	The owner of the goods, the party who wants to send the goods.
Logistic service provider or Freight forwarder (LSP)	The LSP coordinates the full itinerary from origin to destination and contracts one or more transporters for carrying out the actual transport along various links on the itinerary.
Transporter / shipping line	Transporters or common carriers are responsible for the actual transport along the different parts of the route. These transporters can be trucking companies, shipping lines, railway companies or others. The transporters own and operate the boats, trucks, trailers, trains etc.
Cargo insurer	The actor who provides insurance for the cargo during the transportation process.
Customs	The authority or agency in a country responsible for collecting customs duties and for controlling the flow of goods, including animals, transports, personal effects, and hazardous items, into and out of a country. [4]
Port handling agent	The actor who is responsible for the port handling or terminal handling manoeuvres and temporary stocking the containers in the container yard.
Addressee or consignee	The receiver of the goods.
Cargo handling agent	The actor responsible for collecting the goods and consolidating them with other parcels until the container is full. This actor also provides warehousing.
Container owner	This party owns and maintains an inventory of containers to lease them to clients.

The Shipper trusts on the services of a logistic service provider which will coordinate the complete transportation process so that I do not have to bother about insurances or import documents of Customs. Since the LSP does not provide warehousing or transport services themselves, they need to outsource every aspect of the transportation process. But the shipper will see only one bill.

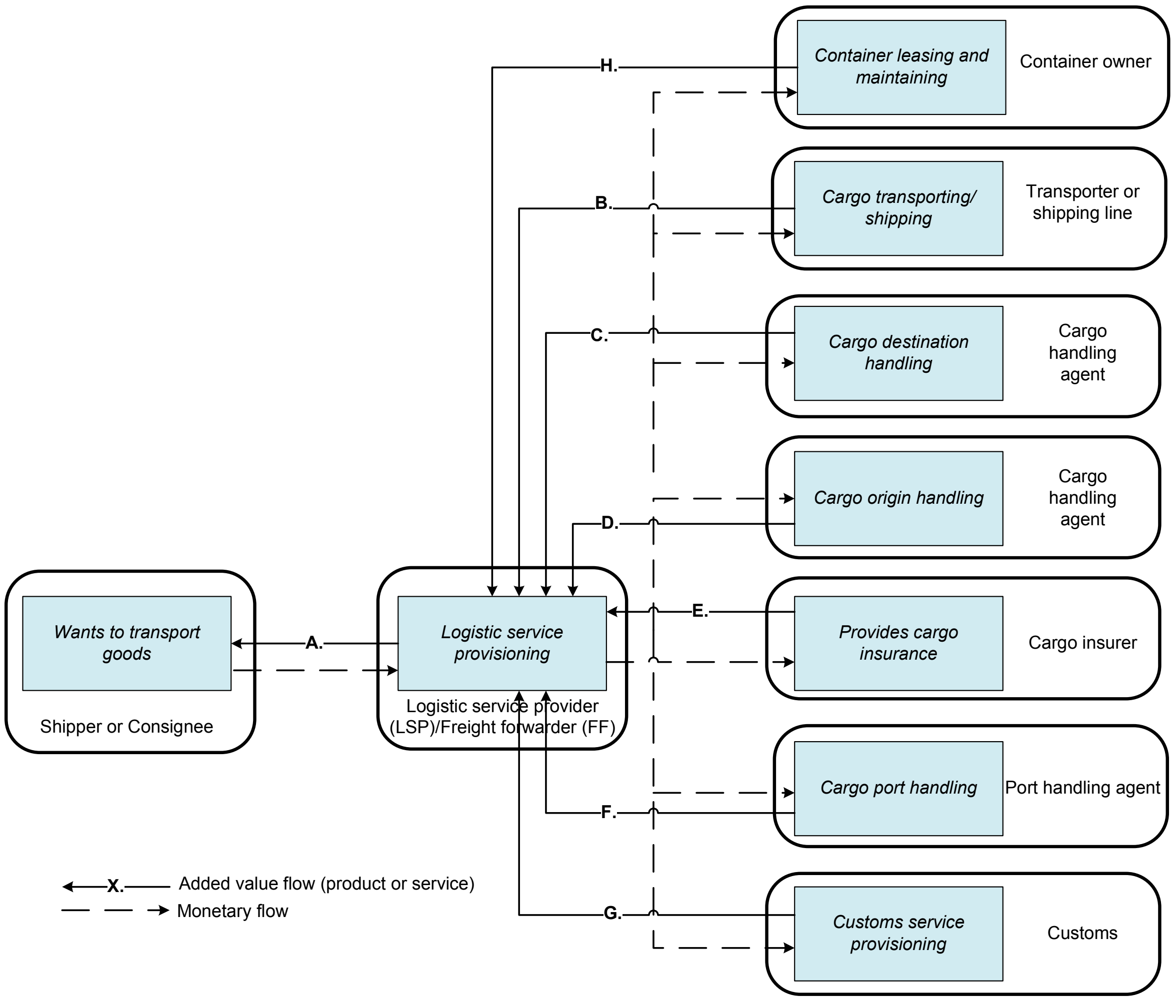

Figure 3: value network configuration of the transport sector in which all roles are fulfilled by individual actors

In this value network configuration, following value exchanging flows can be seen:

- **A.** The LSP will take care of the complete transport process for his client, the shipper.
- **B.** Contracted transporting and shipping lines will move the cargo from point A to B, B to C and so on.
- **C.** Local agents or contract workers will consolidated and regroup the goods for further distribution. Also temporary warehousing services could be provided.
- **D.** Idem C
- **E.** Cargo insurance will be foreseen.
- **F.** Containers will be loaded and unloaded from the vessels.
- **G.** Customs will deal with the regulatory aspects of import and export.
- **H.** Containers are provided.

Those services are exchange products. Thus financial flows must be in place in order to enjoy these services. These flows are indicated with a dashed arrow.

If the LSP fulfils also several other roles within the logistic chain such as warehousing, cargo handling, transport, container renting, etc. the LSP is often referred to as '3PL' or Third Party Logistics provider (see Figure 4).

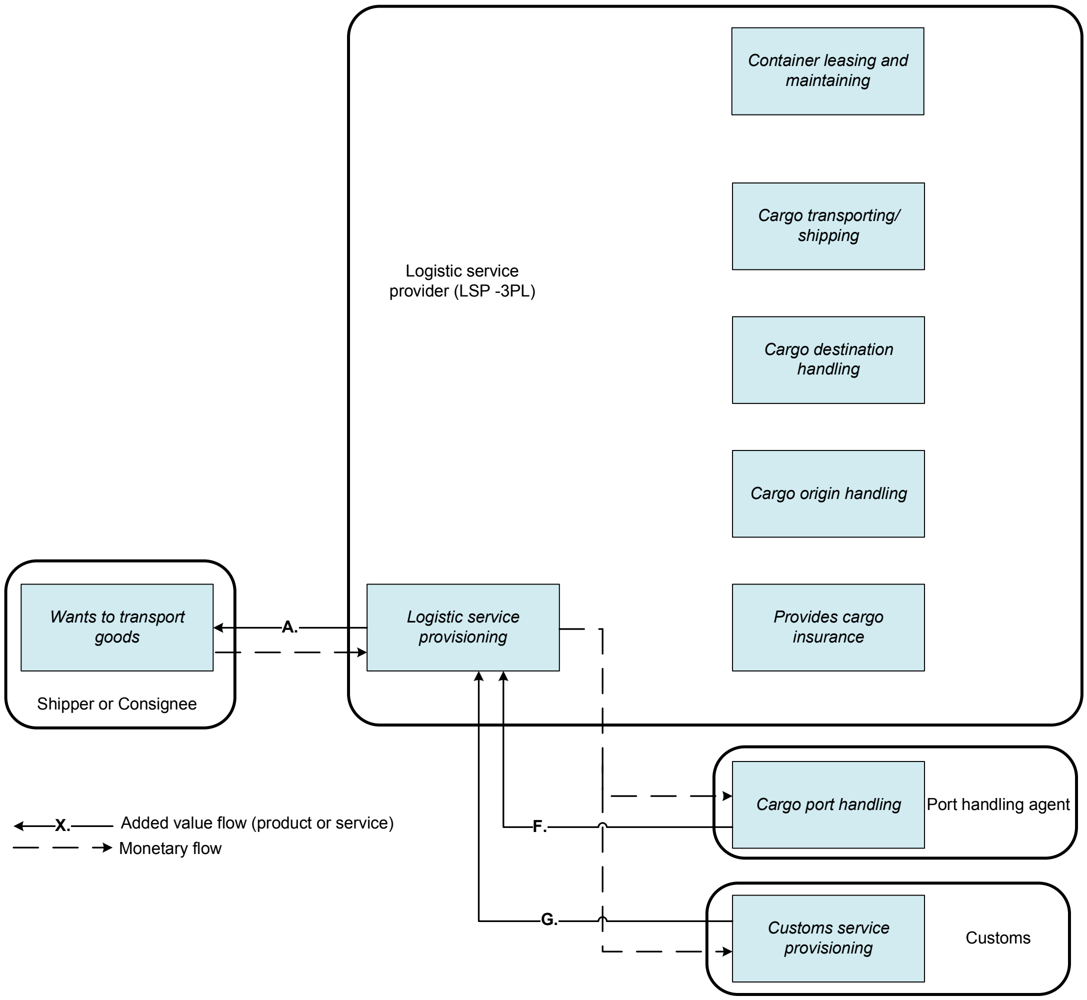

Figure 4: value network configuration of the transport sector in which multiple roles are fulfilled by the 3PL-LSP.

c. Benefits of container monitoring

Having access to various container data such as location, speed, temperature, state of the doors (open or closed), acceleration and humidity is valuable for several actors. But why is it valuable and what can be done or improved based on this data?

To detect the impact of container monitoring several interviews with transporters, logistic service providers, container monitoring service providers, clients and Customs have been conducted. The insights they provided, combined with available literature [1] [5] [6], allow to describe the potential benefits for the involved actors (table 4).

Table 4: Description of benefits for the various actors

Shipper	
Secure trade lane	Certainty on cargo tampering and cargo theft is highly desired whenever the cargo is expensive or theft sensitive like alcoholic beverages, electronics and tobacco products.
Transparent quality monitoring	Prediction and monitoring of cargo pilferage allows shippers to anticipate bad cargo before it arrives.
Lead time reduction (or transit time reduction)	Because of a better and real time data flow, less waiting time of containers at the destination harbour can be expected. [7] indicates that containers arrived at the destination harbour wait between 4 hours and 3 days before being picked up by the destination handling agent.
Increased customer response time	In case of timely detection of a transport delay (e.g. Hold up by Customs, lost container, etc.) the Shipper can resend a batch. This is very important for products of which the value is characterized by seasonality trends such as clothes in times of seasonal sales, toys deliveries around the Christmas period, etc.
On time delivery	More on time deliveries as a result of all fields of impact described above. This is crucial in just-in-time processes.
Container owner	
Better asset management and increased utilization	Better container management and higher container utilization which could result in a fleet size reduction.
Competitive advantage	Having smart containers and the container data available in the product or service portfolio for clients is at this point in time a competitive advantage. It has the potential to attract new clients and to generate new revenue streams.
Logistic service provider (LSP)	
Cost reduction	Accurate data and a real time information flow on the location and state of the containers (e.g. Time of pick up by terminal crane) will lead to a more fluent and simplified administration. A more fluent and automated administration will result in a cost reduction.
Competitive advantage	Cfr. Container owner
Better customer relationship	Since lead or transit time reduction are beneficial for shippers, the clients of the LSP, one can expect a higher customer satisfaction and even attraction of new customers.
Improved supply chain visibility	Increased process transparency is appreciated by the clients and the subcontracted agents like the transporters. Also, more and more international organizations and governments (e.g. World Customs Organizations, the U.S. Customs Trade Partnership against Terrorism (C-TPAT) and Europe's new Authorized Economic Operator (AEO) program [1]) require so called secured lanes, which foresee in end-to-end security].
Better organization of intermodal connections	Process time reduction realized by automated administration and logging of container movements. But also the coordination of subcontractors could benefit from knowledge on cargo location (less container waiting time in the destination port, real time data on cargo availability for transporters (e.g. Customs control interruptions, etc.)
Transporter	
Less waiting time	Subcontractors could benefit from knowledge on cargo availability to trigger pick-up processes (e.g. tackling process time variation due to unplanned Customs control, etc.)
Customs	
Reduction of container processing time	Container door opening events as triggers for inspections and other customs clearance processes.
Increased safety level	Containers are often filled with Phosphine (PH3), Sulfuryl fluoride (SO2F2) or other fumigants for controlling the ripening process of natural products

	or to exterminate all insects, or other life sources in a container to prevent ecological and biological contamination. Before inspecting and entering a container, Customs need to be sure that the concentration of these gasses is reduced to acceptable levels. Gas or oxygen concentration monitoring can be performed by container monitoring devices.
Port or Terminal handling actor	
Container handling and administration time reduction	Process time reduction realized by automated administration and logging of container movements.
Cargo insurer	
Traceability and certitude of responsibility issues	Traceability of the responsible actor in case of tampered or damaged goods during the transport process.

II. Objective

Literature sources and our research confirm that smart containers could have a significant impact when integrated in current transport processes. Focus of available literature is mainly on three topics [1] being: 1) the technological challenges [8] (e.g. battery life, wireless communication inside the container, etc.), 2) impact on transport security [9] [10] and 3) preventable losses of perishable goods [11]. However the total operational impact of smart containers is much broader. Better inventory management, faster container handling (e.g. Customs services), real-time supply chain adjustments, etc. are just many of the other fields of impact.

The goal of this research is to quantify the total impact on the goods and processes that depend on it, when introducing smart containers into current transport cycle. The ROI-model (Return on Investment) is based on the VOT- method (Value-Of-Time) [6] and depends on the type of good transported and is performed for a wide range of products (cereals, tobacco, electronics, etc.), as categorized by the SCTG- coding system [12].

III. Methodology

What all shippers have in common is that transporting goods requires a lot of capital. Not because transportation costs money but because it means that the value of the cargo is frozen for the time that the goods are underway. Next to this cost of capital there are also inventories and safety buffers needed to overcome the lead time of the transport. In addition the Time-to-market, chances on damage or pilferage, etc. are also impacted because of the lead time duration.

All those factors imply that time has an important monetary value.

The calculation model is built on this principle and is described in [6]. The question is how container monitoring services can impact the lead time of the transport process? The research of [6] on transport lead times revealed surprising conclusions: when containers arrive at the destination port or transhipment place, they wait a significant time until further handling takes place. Table 5 presents the findings in [6].

Table 5: Findings on the waiting time of containers at the ports of origin and destination [6]

Waiting time at ports	Departure port time (hours)	Arrival port time (hours)
Min. waiting time	1	3
Max. waiting time	23	282
Average time	12,83	60,54
Standard deviation	7,04	69,06
Std/Av	0,5488	1,1408

The findings indicate room for improvement. We assume conservatively that a lead time reduction of 33% (20 hours, validated by project partners) can be realized when implementing smart container monitoring services. In order to quantify this lead time reduction, time has to be valued.

Value of time should be interpreted as the opportunity cost for a shipper for the transport of the cargo from point A to B [6]. In other words, it is the price the Shipper would be willing to pay for a certain lead time reduction. In literature, a lot of attention went to the quantification of Value of Time (VOT) [5] [6] [13] [14]. VoT-factors depend on the type of cargo (e.g. container filled with iron ore vs. container full of smartphones, etc.). Therefore different VoT-factors are modelled per commodity group. In the model, two different sets of VoT-values are used [5] [6]. These are given in Table 6. The difference between the two sets is that SET1 is a VoT-multiplier that needs to be multiplied with the value density [euro/ton] of the cargo, which depends on the value of the good. SET 2 on the other hand is fixed VoT value per NSTR-chapter (Nomenclature uniforme des marchandises pour les Statistiques de Transport, Revisée).

Table 6: NSTR-1 Chapters and the according VoT-values

Chapter [NSTR, 1 digit]	SET 1 [6] Calibrated using the NSTR-2 classification [$ / $ value of goods – day]	SET 2 [5] [Euro/tonne/hour]
0. agricultural products and live animals	0,0035	0,18
1. foodstuffs and animal fodder	0,0035	0,21
2. solid mineral fuels	0,0035	0,09
3. petroleum products	0,0035	0
4. ores and metal waste	0,0035	0,16
5. metal products	0,0035	0,38
6. crude and manufactured minerals, building materials	0,0035	0,1
7. fertilizers	0,0035	0,16
8. chemicals	0,0035	0,21
9. machinery, transport equipment, manufactured and miscellaneous articles	0,0035	0,66

IV. Model structure

Via lead time reduction, the value of smart container monitoring services can be expressed per type of good. This value or benefit needs to be weighed with the costs/investments needed to implement these services. A four step model (Figure 5) has been developed to analyse the costs and benefits of integrating smart container services via ROI-analyses (from a Shippers perspective).

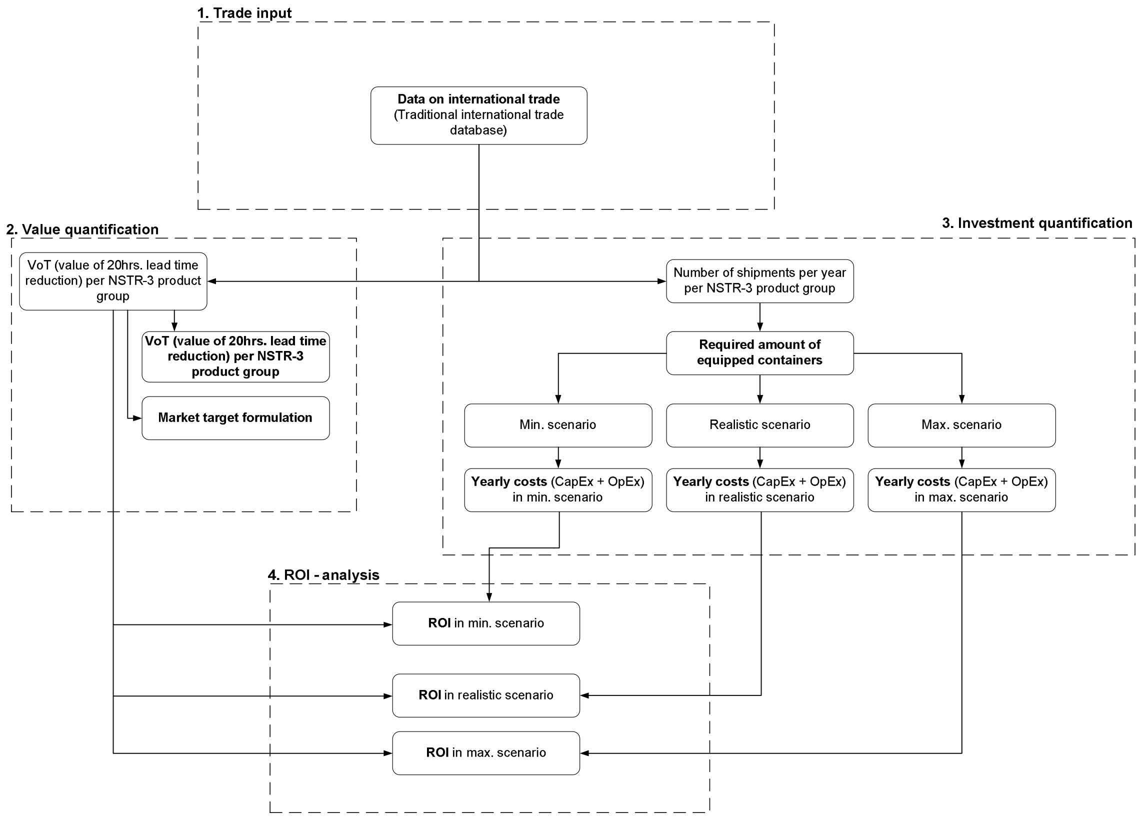

Figure 5: Schematic overview of the calculation model

1. *Trade input*

This model uses trade lane data of the Traditional international trade database (ComExt) of Eurostat [15]. This database provides us with the type, value and quantity of imported and exported goods from the European Union via Sea, during a specific year.

2. *Value quantification*

Both the value of the shipped goods and the quantity of it allow formulation of the value density [euro/ton] and the number of shipped containers. Based on these numbers, the VoT-benefits can be calculated for the expected lead time reduction and only for the products for which container monitoring services can be of value. For example, it would be unlikely that a container filled with living animals will wait on average 60 hours before it will be picked up for destination handling. To tackle this, all 176 NSTR-3 cargo positions are validated. Examples for excluded types of cargo: Live animals, crude oil, blast-furnace dust, etc.

3. *Investment & cost quantification*

In the previous steps an average amount of container trips per year per product position is derived. But how many containers need to be equipped with container monitoring devices in order to meet that amount of container trips?

The number of needed containers depends heavily on the container utilization. Because container utilization is a variable that we do not know, we define three scenarios;

A. *Minimum amount of containers:*
In a perfect closed loop scenario (best case scenario) the container has a maximum utilization. This means that containers are used multiple times a year. The minimum amount of containers is defined as the minimum amount of containers needed to send the goods to their destination and to be sent back, including time to handle the containers (total handling time assumed as transport time). Following formula approaches the minimum amount of containers.

$$\text{minimum amount of containers} = \frac{\text{container trips per year}}{\left(\frac{365}{(\text{transport time} * 3)}\right)} \quad (1)$$

with:

transport time = the time that a container needs to go from origin to destination in days

For example: there are 100 container trips to China each year. One trip takes 30 days. This would mean that about 25 containers are needed to cover all the trips.

B. *Realistic amount of containers:*
Because it is unlikely that all container trips are perfectly distributed over a year and that a container will always require exactly 3 times the transport time to be back at the starting point, we add some extra container buffer capacity to the minimum required amount of containers.

$$\text{realistic amount of containers} = \frac{\text{container trips per year}}{\left(\frac{365}{(\text{transport time} * 3)}\right)} * (1 + \text{additional container buffer \%}) \quad (2)$$

with:

transport time = the time that a container needs to go from origin to destination in days

additional container buffer % = extra added buffer capacity

For example: there are 100 container trips to China each year. One trip takes 30 days. The container trips are not perfectly distributed over a year (at some point in time I need to send 50% more containers to the destination). So some additional container capacity should be foreseen. This would mean that about 37 containers are needed to cover all the trips.

C. *Maximum amount of containers:*
This is a worst case scenario. It means that every container is sent to destination once a year. Thus we need as many containers as there are container trips.

$$\text{maximum amount of containers} = \text{container trips per year} \quad (3)$$

On top of the infrastructure investment and replacements cost (Capital Expenditure: CapEx), service provisioning and infrastructure maintenance results in recurring operational expenditures (OpEx).

The magnitude of the investments is driven by the desired amount of deployed containers. The formulation of a market goal over a certain period is modelled via a Gompertz adoption curve [16]. Depending on the desired market share, this curve provides a deployment planning.

4. Return on Investment (ROI) and Pareto–analyses

Because the added value of monitoring goods transported in a container does sometimes not justify the yearly cost of this service, together with the fact that container services for some goods result in a higher added value than for other products, focus is needed.

Applying the Pareto principle (defining the share of goods that determine 80% of the total added value resulting from smart container services), only 10 of the 176 NSTR-product groups are identified as focus groups. Following figure 6 presents an example of such a Pareto group of focus products in the EU- China trade lane.

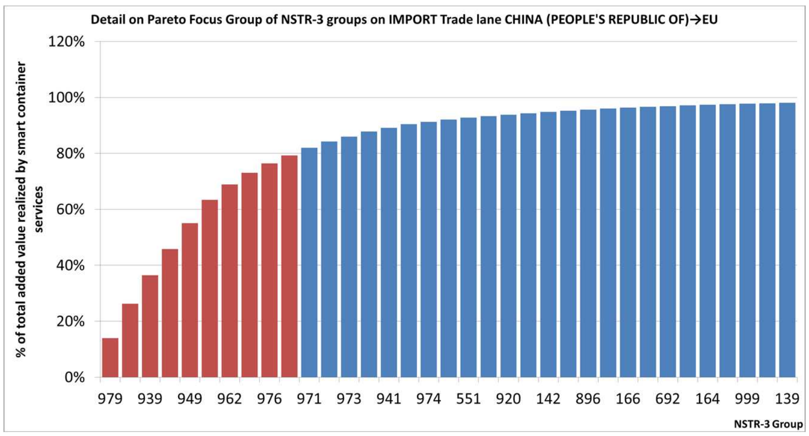

Figure 6: Detail on the Pareto group of products in the trade lane EU → China

On a micro-level ROI-analyses are performed from the perspective of Shippers. Input is provided by industrial partners within the project consortium.

Shippers will be willing to pay only on the condition that the benefits of these container monitoring services are bigger than the costs for it. This means that a positive return on investment (ROI) is needed.

The ROI is given by:

$$\text{ROI} = \left(\frac{\text{net benefits}}{\text{costs}}\right)*100$$

with: (4)

net benefits = benefits - costs

The model calculates the ROI for each type of cargo (NSTR-3 position).

5. Model overview

Based on the described functionality and workflow of the model, an overview of all model inputs and outputs can be described. Figure 7 provides a schematic model overview.

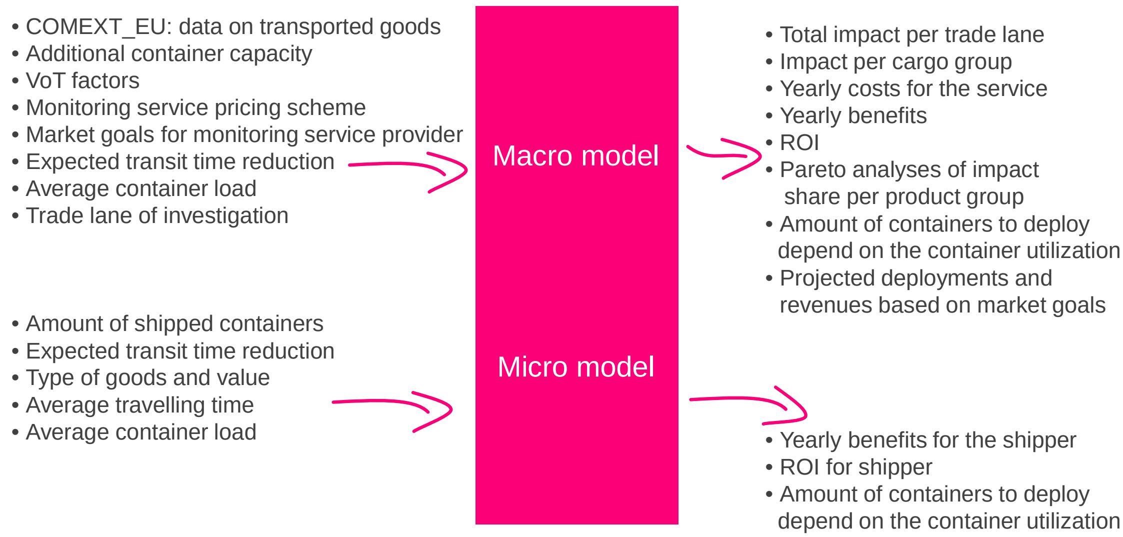

Figure 7: Overview of the model in- & outputs

The model exists of both a Macro and Micro component. The Macro component of the model calculates the benefits per product type according to a chosen trade lane; import/export; EU ↔ China, EU ↔ US and EU ↔ EU. The results of the macro model indicate the benefits container monitoring services can provide for a certain product in certain trade lane. From the perspective of Smart Container Service Providers and Logistic Service providers this in interesting information because it also provides on which products to focus on to market container monitoring services.

On the other hand the Macro model is not interesting from the Shipper's perspective because it does not show the impact of smart containers on his own transport process. Therefore a Micro model is developed as well. The results of the Micro model indicate the ROI for the shipper when making use of container monitoring service.

V. Results

In what follows the most important results of the Macro model are provided. For both the trade lanes China <-> EU and U.S <-> EU (import and export flow), the total potential impact of container monitoring services will be compared.

Table 7: summarization of the results of the Macro model

	EU → China	China → EU	EU → US	US → EU
Total impact when all container trips for which monitoring container services would be interesting would save 20hrs. lead time	183 M euro per year	399 M euro per year	204 M euro per year	143 M euro per year
Nbr. Of equipped containers ***Min. scenario***	412 000	487 000	115 000	141 000
Nbr. Of equipped containers ***Realistic scenario***	617 000	729 000	172 000	212 000
Nbr. Of equipped containers ***Max. scenario*** *(= total number of shipments)*	1 646 000	1 945 000	1 375 000	1 695 000
ROI Min. scenario	274 %	589 %	1395 %	753 %
ROI Realistic scenario	149 %	359 %	897 %	468 %
ROI Max. scenario	-7 %	72 %	25 %	-29%

It can be noticed that although the total number of shipment between the different trade lanes varies maximum about 40%, the ROI's vary much more. This is related with the fact that the total impact is dependent on the value of the shipped goods. Since EU import mostly NSTR-chapter 9 products from China, which have a high value of time, the total impact is bigger in this flow compared to flows with less high valuable shipments (table 7).

Since the travelling time from the U.S. to EU is noticeably less than from the China to the EU, respectively about 10 days versus 30 days), equipped containers can be used three times more often in the min. scenario of the import trade lane U.S. → EU than in the import trade lane China → EU. This can be seen in the number of equipped containers in the minimum and realistic scenarios. This results automatically in a higher ROI because for the same investment a shipper in the U.S. → EU trade lane can enjoy three times more container monitoring services.

The Pareto analysis provides the group of products which together realize about 80% of the total potential impact of container monitoring services in a certain flow. Table 8 presents a description of the Pareto product types per flow. These products could be worthwhile to focus on when marketing container monitoring services.

Table 8: NSTR-3 position description of Pareto products

EU → China
842 waste paper and scrap articles of paper
910 transport equipment, whether or not assembled, parts thereof
939 non-electrical machinery, apparatus, appliances and engines; parts thereof
999 other manufactured goods not classified according to kind
891 plastic materials, unworked
841 paper pulp
051 paper pulp wood
632 building and monumental stone, unworked
973 paper and paperboard manufactures
972 paper and paperboard, unworked
839 pitch, mineral tar and other crude mineral chemical derivatives from coal and natural gas
451 non-ferrous metal waste
819 other basic chemicals
931 electrical machinery, apparatus, appliances and engines; parts thereof
949 other manufactures of metal
056 railway or tramway sleepers of wood and other wood roughly squared, half squared, or sawn

China → EU
979 other manufactured articles
931 electrical machinery, apparatus, appliances and engines; parts thereof
939 non-electrical machinery, apparatus, appliances and engines; parts thereof
963 travel goods, clothing, knitted and crocheted goods, footwear
949 other manufactures of metal
975 furniture, new
962 textile yarn, fabrics, made-up articles and related products
910 transport equipment, whether or not assembled, parts thereof
976 wood and cork manufactures, excluding furniture
952 glassware, pottery and other manufactures of minerals

Eu → us
910 transport equipment, whether or not assembled, parts thereof
939 non-electrical machinery, apparatus, appliances and engines; parts thereof
972 paper and paperboard, unworked
999 other manufactured goods not classified according to kind
819 other basic chemicals
973 paper and paperboard manufactures
551 tubes, pipes and fittings
975 furniture, new
949 other manufactures of metal
931 electrical machinery, apparatus, appliances and engines; parts thereof
122 beer made from malt
971 semi-finished products and manufactured articles of rubber
979 other manufactured articles n.e.s.
891 plastic materials, unworked
952 glassware, pottery and other manufactures of minerals
920 tractors; agricultural machinery and equipment, whether or not assembled; parts thereof
724 nitrogenous fertilizers
962 textile yarn, fabrics, made-up articles and related products
896 other chemical products and preparations

US → EU
181 oil-seed fats, oil nuts and oil kernels
819 other basic chemicals
972 paper and paperboard, unworked
057 fuel wood, wood charcoal, wood waste, cork unworked, waste cork
973 paper and paperboard manufactures
910 transport equipment, whether or not assembled, parts thereof
939 non-electrical machinery, apparatus, appliances and engines; parts thereof
172 oil-cake and residues resulting from the extraction of vegetable oils
841 paper pulp
179 bran, cereal by-products and other animal feeding stuffs n.e.s.; waste from food industries
891 plastic materials, unworked
211 coal (ecsc)
011 wheat, spelt and meslin
979 other manufactured articles n.e.s.
999 other manufactured goods not classified according to kind
896 other chemical products and preparations
931 electrical machinery, apparatus, appliances and engines; parts thereof
949 other manufactures of metal
813 sodium carbonate (soda ash)

As stated earlier, the model allows formulating market targets from the perspective of a container monitoring service provider. The goal is to project the cumulative revenue resulting from container monitoring services, based on the required deployment in order to reach the market goal.

In what follows an example is provided that indicates the needed number of equipped containers and the resulting revenue stream. This is based on a market target of realizing 1% of the total potential impact of container monitoring services resulting from the Pareto products in the export and import flows EU → China within a time frame of 10 years from now.

Figure 8 shows the relative targeted adoption on the right axis, the left axis indicate the gross cost savings or impact that would result from this market penetration.

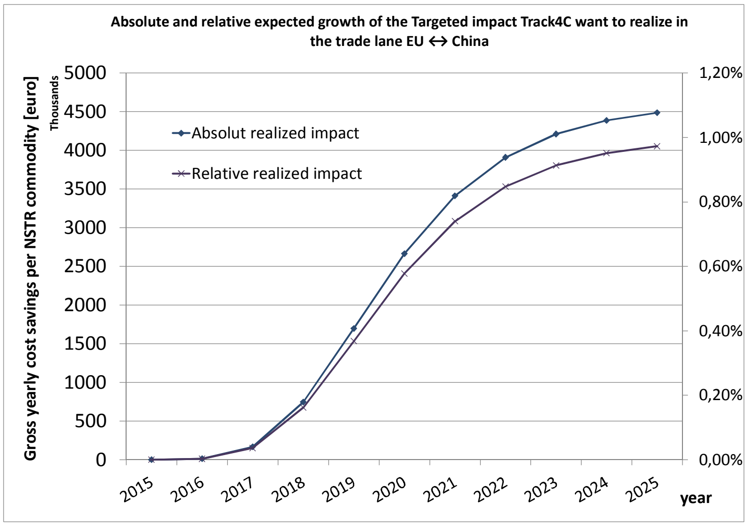

Figure 8: Relative share and absolute growth of the targeted market impact the container service provider wishes to realize

The targeted market penetration requires a deployment strategy. Coming back on the different deployment scenarios (min. realistic and max.) following deployment projection is provided (figures 9- 12).

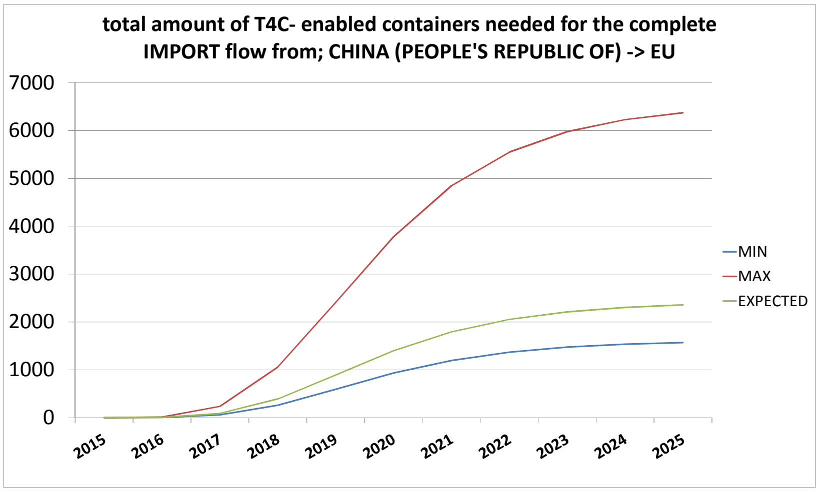

Figure 9: Required number of equipped containers to reach the goal (Import lane)

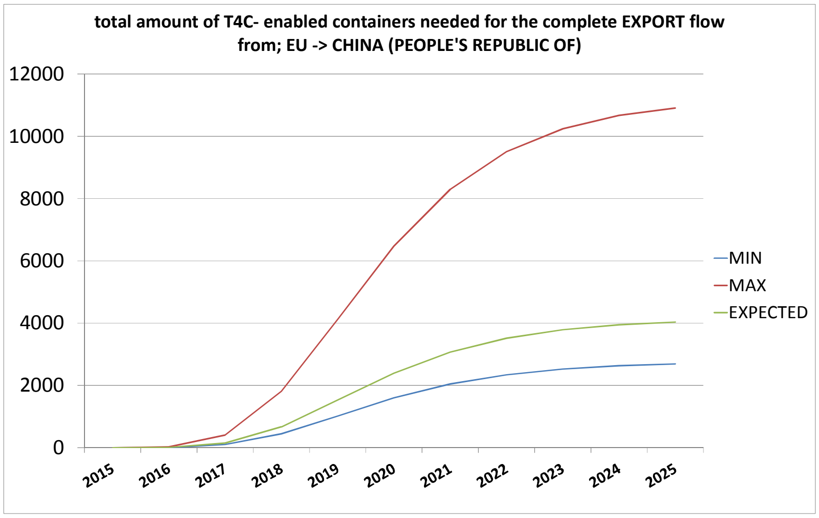

Figure 10: Required number of equipped containers to reach the goal (Export lane)

The model does not assume that a container that is used to send a particular good from EU to China will be used to transport the same type of good one his way back. In reality that probably will occur, but in this model there is no overlap between the import and export flow modelled. Therefore the model calculates for both the import and export flow the required number of containers.

Once the boundaries of the container deployment are known, projections can be made based on the pricing scheme of the container monitoring service provider.

This is done for both the import and export flow. Like stated earlier, there will be an overlap between this to projections. As can be seen in the charts 21 & 22 below, based on the market target to realize 1% of the total potential savings in the China-EU trade lane within a time window of 10 year, cumulative gross revenues between 1.2 – 5.2 Million euro and 2 – 9 Million euro for respectively the import and export flow are projected.

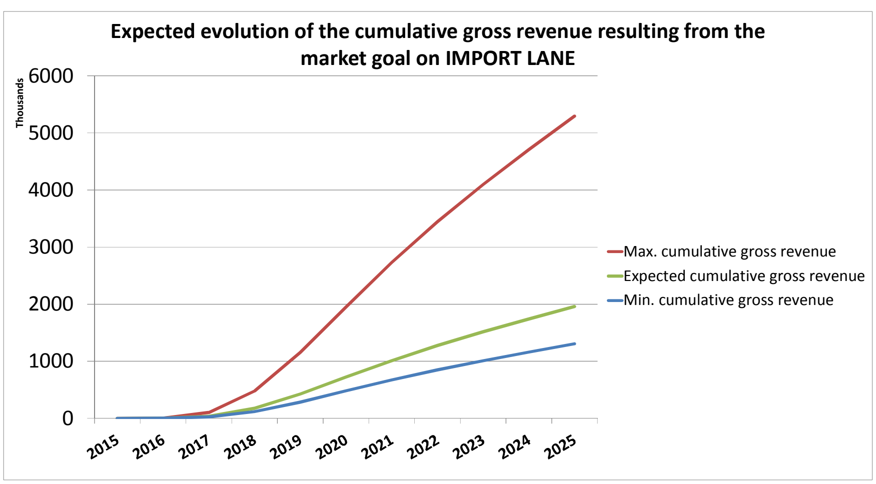

Figure 11: Projections of cumulative gross revenue for the container monitoring service provider (Import lane)

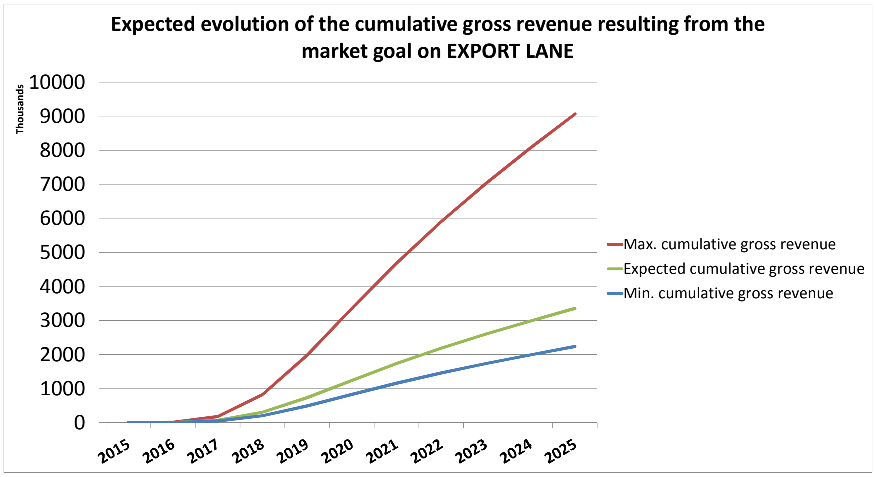

Figure 12: Projections of cumulative gross revenue for the container monitoring service provider (Import lane)

This model indicates a large potential for container monitoring service providers in the current value network for freight transportation.

VI. Discussion

The main idea of this document is to provide insights that can help answering following questions regarding the business case of a constrained monitoring use case:

- What are the benefits for the various actors involved in the transport sector?
- What is the value of smart container monitoring services? How to quantify the benefits?
- What are the most interesting commodities to focus on? How to prioritize the market?
- Can investments in container monitoring services lead to interesting ROIs?

In order to answer the above questions, first an introduction and overview of smart container services, the transportation sector and its value network are presented.

After formulating the most important benefits for each actor involved in the transportation process, the benefits and ROI for the shipper are quantified. Therefor a calculation model is used that relies on the assumption that smart container monitoring services can reduce the lead time of the transportation process. Value of Time (VoT) factors have been used to translate the value of time for goods in transit to a monetary value. A Pareto analysis of international trade lanes prioritized the goods to focus on or in other words equip containers with container monitoring devices.

Depending on the value of the good, a positive ROI can be presented in most cases. The Macro model aggregates all data of overseas containerized transport of 2013 for different trade lanes (EU – China, EU – US and EU – EU). It indicates that if smart containers could lead to a transit/lead time reduction of 20hrs for all the types of goods for which container monitoring services could be interesting, a total impact of 183- 399 Million euro can be expected dependent on the trade lane of investigation (ROIs ranging from -29% to almost 1400%).

Currently the market for container monitoring services is still in development phase. But because of the additional revenue these services could generate, interest is growing fast. On top of that, it can be expected that the efforts of regulatory organizations and programs such as WCO, C-TPAT, AEO, etc. to install secure and transparent trade lanes will drive the adoption as well.

VII. Future work

Despite the overall positive impact smart container monitoring services can result in, not every actor is pleased with a complete transparent supply chain process. If the shipper knows exactly where the goods are at each point in time, only little room is left for the logistic service providers to aggregate transports and optimize their internal processes. Often shipments from different shippers are combined, resulting in suboptimal process for the shippers.

Another challenge is allocating the required investment to the various actors in a sustainable way. If there is no good balance between the investments and benefits or cost/benefit ratios amongst the various partners, it is unlikely that offering smart container service monitoring is sustainable.

Being able to understand and tackle potential barriers allows better formulation of go to market strategies for container monitoring service providers and would be a valuable extension on this work.

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