D1.4.2 USER STORIES

DESCRIPTION OF THE PROBLEMS ADRESSED, THE USE CASES DEVELOPPED AND THE ASSUMPTIONS TAKEN

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0 Introduction

After the first step of familiarising ourselves with the stakeholders, their main interests and motives and their relationships we continued to identify the main challenges, requirements and solutions for the PILL information system to address during this process, we also defined specific business roles PILL stakeholders can fulfil, grouped into 3 main roles: logistic, policy and governance. These business roles where then used to construct the specific user stories in the current document. (see 1.2 Stakeholder Mapping for a detailed overview).

The current document focusses on the development of the use cases and assumptions and is a result of a co-creation trajectory which consisted of the following steps:

- Initial 1 on 1 interviews with all board members detailing their business process and main challenges
- 2 workshops with the advisory board member addressing (1) business and (2) technical challenges to be addressed in the POC
- Follow up 1 on 1 meetings with specific partners relevant to the POC to further detail the scope.

In the first chapter of this document, the main challenges will be displayed. To answer these wicked problems, use cases are formulated in chapter 2, consolidating insights from the interviews with advisory board members, literature research into the current state of the art in PI (see 1.1 Physical Internet Literature review and technical component listing) and a mapping of the current processes within a maritime port and its hinterland connections (see 1.3 Maritime port and container logistics infrastructure and procedures mapping).

The third chapter zooms in on the list of assumptions that exist towards the use cases and where identified during the process of creating the use cases. Assumptions represent a major risk when innovating and it is therefore important that the existing assumptions are recognised and validated. These were organised in 3 main categories: 'desirability', 'feasibility' and 'viability'.

In the final chapter we conclude by identifying the key assumptions that will be validated in the POC (see 4.1 Living lab intervention scenario description).

1 Main Wicked Problems and high-level use cases

Freight transport today is under pressure to revise its way of working by between increasing demand on the one hand and high ambitions for sustainability on the other hand. Freight transport by road is expected to increase by around 40% by 2030 and 80% by 2050 (EC, 2016). To make this compatible with the Paris environmental agreement, a drastic reduction of emissions is needed. By 2030, the ambition of the European Commission (EC, 2011) is to shift 30% of freight transported by road to environmentally friendlier modes that have lower societal impact, such as rail and inland waterways. This shift should increase to 50% by 2050.

At the same time, the use of the current logistics network capacity is limited. Many companies focus on road transport with known partners and have little knowledge of optimisation opportunities. They are unable to evade known bottlenecks in the network as they have only limited insights in workarounds and optimisations. At the basis of this is a digital disconnect between the different stakeholders. Because of this, companies focus on internal optimisations. Digital transformations are done through non-scalable point-to-point solutions, making a more interconnected network hard to achieve. This specifically hinders smaller players, as they are forced to either commit to working with one higher level LSP only or to combine the use of several, non-matching standards (adding to the administrative workload and the risk of errors).

Through discussions with our Advisory Board members, we identified three key (Wicked) problems arising from this state of affairs, which are to be addressed in PILL:

(1) Due to the steady increase of maritime vessel size (leading to a decrease in costs) and the importance of global supply chains, container transport has risen all over the world. The current logistics system has not been built for these (peak)volumes of containers and is becoming more and more incapable of keeping up with this increasing (peak)demand. This leads to congestion on specific nodes or links in the chain, while other nodes and links still have capacity available. Due to the digital disconnect between parties, expeditors lack visibility on the overall capabilities and are not able to even consider alternative solutions.

(2) Due to the nature of the logistics process, it is vulnerable to small ad-hoc disruptions. Not everything in the real world can be predicted long in advance, like traffic jams due to accidents, technical malfunctions of infrastructure or equipment, floodings,… . These disruptions are often out of the control of the individual stakeholders and often only appear late in the transport process. This necessitates the system to respond in real-time, while only limited real-time information is available. Solutions are therefore often suboptimal, adding to delays and costs.

(3) The asymmetric nature of most logistic flows often leads to equipment imbalances, which makes it necessary to reposition empty assets. This is mainly an issue for maritime containers and trucks, as they need to return to their original location. Although this imbalance is inevitable to some extend, it can be limited by taking flows of other companies, moving in the reverse direction, into account. Filling up this empty capacity will reduce both costs and external impacts, as an additional trip is avoided. Additionally, being able to predict where and when an imbalance will occur, will allow for a more efficient repositioning.

These three factors lead to a cascading effect of delays and changes in routes, making it hard to plan ahead and anticipate changes along the way. From this, three key wicked problems were identified: Improving interoperability between stakeholders, increasing resilience against disruptions and optimisation of use of assets. Consequently, the PILL use cases were determined to provide (part of) a solution for each of the three problems.

The Wicked Problems, use cases and user stories in this chapter have been derived from in-depth interviews with stakeholders (following the stakeholder map Task 1.2) and refined through workshops and validation meetings with the PILL consortium partners.

Wicked Problems:	Focus of Use case:
Improve planning reliability How might we increase transparency of the activities of different stakeholders, so we can create a more reliable planning?	**Optimization of intra-port logistics processes** ***As a*** *logistics company active in the Port of Antwerp,* ***I want to*** *better align with the planning of other stakeholders in the port* ***So I can*** *work more efficient and reliable.*
Increase resilience against disruptions How might we increase communication (data) about real-time availability across and status of the network, so transporters and forwarders can make more validated decisions during disruptions?	**Aligning import and export in the hinterland** ***As a*** *logistics related stakeholder in Flanders,* ***I want to*** *increase real-time visibility of the hinterland network* ***So I can*** *better anticipate my route*
Optimise future (planning) processes How might we increase overall collaboration between stakeholders, s so we can improve the overall efficiency of the logistics process	**Empty container flow optimization** **As a** container user, **I want to** better coordinate the flow and balance of my empty containers across the network **so I can** increase the efficiency of my transport flow

Table 1: Relationship Wicked problems & use cases

1.1 Overview Use cases & User stories

The 3 use cases were as followed:

1. **Planning of intra-port logistics processes**
   As a *logistics company active in the Port of Antwerp,*
   I want to *better align with the planning of other stakeholders in the port*
   So I can *work more efficient and reliable.*

2. **Respond to disruptions**
   As a *logistics related stakeholder in Flanders,*
   I want to *increase real-time visibility of the hinterland network*
   So I can *better anticipate my route*

3. **Empty container flow optimization**
   As a container user,
   I want to better coordinate the flow and balance of my empty containers across the network
   so I can increase the efficiency of my transport flow

Title	Description
Use case 1: planning of intra port logistics processes	
Intra-port alternatives	***As a*** *(road)transport provider* ***I want to*** *have a better view on cross-bank transport possibilities (barge, train)* ***so I can*** *avoid congestion delays during truck transport*
Next mode of transport	**As a** terminal operator **I want to** know the next transport modes **so I can** gain time to optimize my operations and reduce waiting times4nm1ew
Increase reliability of import moves	***As an*** *expeditor,* ***I want to*** *increase the reliability of my import moves,* ***So I can*** *optimise work schedules at the unloading location.*
Optimization of flows	***As a*** *policy maker* ***I want to*** *optimize logistic flows* ***so I can*** *reduce external costs.*
Use case 2: Responding to disruptions	

Adapt to changing ETA	***As a*** *cargo owner* **I *want to*** *get an updated ETA* ***so I can*** *optimize my flow of goods*
Make free capacity findable	***As a*** *transport provider* ***I want*** *to make my free capacity findable* ***so I can*** *reduce my empty kilometres.*
Adapt route selection	***As an*** *expeditor,* ***I want to*** *be able to keep track of changing conditions in the logistic network* ***So I can*** *be able to optimise my transport flows as much as possible.*
Optimise infrastructure use	***As an*** *infrastructure manager,* ***I want to*** *be able to guide traffic flows* ***So I can*** *make maximal use of capacity and reduce congestions to a minimum.*
Use case 3: Empty container flow optimization	
Container reuse	***As a*** *cargo owner* ***I want to*** *check if reuse of an empty container is possible / profitable* ***so I can*** *avoid unnecessary trips with empty containers*
Container repositioning	***As a*** *hinterland terminal operator* ***I want to*** *check if empty containers will be available/needed* ***so I can*** *balance my equipment*

Table 2: Overview use cases & user stories

2 Description use cases & stories

In the previous chapter, we discussed the three key Wicked Problems that will be the focus of the PI blueprint. In this chapter we will answer these by building three use cases. For each of them we defined 3-5 user stories together with logistics stakeholders that represented specific, key challenges that logistics companies are struggling with today. These user stories were determined based on 80/20 principle, which states that 80% of the problems derive from 20% of the activities. By solving these key user stories, we can thus assume we solve the majority of the challenges for each use case.

The table below gives an overview of these use cases. This chapter continues to further details the use cases, elaborating on the general description provided above.

Title	Description
Use case 1: planning of intra port logistics processes	
Intra-port alternatives	***As a*** *(road)transport provider* ***I want to*** *have a better view on cross-bank transport possibilities (barge, train)* ***so I can*** *avoid congestion delays during truck transport*
Next mode of transport	**As a** terminal operator **I want to** know the next transport modes **so I can** gain time to optimize my operations and reduce waiting times4nm1ew
Increase reliability of import moves	***As an*** *expeditor,* ***I want to*** *increase the reliability of my import moves,* ***So I can*** *optimise work schedules at the unloading location.*
Optimization of flows	***As a*** *policy maker* ***I want to*** *optimize logistic flows* ***so I can*** *reduce external costs.*
Use case 2: Responding to disruptions	
Adapt to changing ETA	***As a*** *cargo owner* ***I want to*** *get an updated ETA* ***so I can*** *optimize my flow of goods*
Make free capacity findable	***As a*** *transport provider* ***I want*** *to make my free capacity findable* ***so I can*** *reduce my empty kilometres.*

Adapt route selection	***As an*** *expeditor,* ***I want to*** *be able to keep track of changing conditions in the logistic network* ***So I can*** *be able to optimise my transport flows as much as possible.*
Optimise infrastructure use	***As an*** *infrastructure manager,* ***I want to*** *be able to guide traffic flows* ***So I can*** *make maximal use of capacity and reduce congestions to a minimum.*
Use case 3: Empty container flow optimization	
Container reuse	***As a*** *cargo owner* ***I want to*** *check if reuse of an empty container is possible / profitable* ***so I can*** *avoid unnecessary trips with empty containers*
Container repositioning	***As a*** *hinterland terminal operator* ***I want to*** *check if empty containers will be available/needed* ***so I can*** *balance my equipment*

2.1 Use case 1: planning of intra port logistics processes

This use case is focussing on the first leg of hinterland transport, which is the pick-up of the container at the terminal (gateway node) and the first move inside the port. This is currently done without much sharing of information, making it hard for the individual stakeholders to plan and optimise their operations. Specifically, the limited view on and (perceived) access to the more sustainable modes of transport (barge and train), leads to a high use of trucks. Although trucks are highly flexible and relatively cheap, they are not well suited for the high peak demands related to large maritime container flows, causing increasing congestion and diminishing reliability.

Today, trucks are often chosen because of their (perceived) lower cost and higher flexibility. However, if the use of train and barge would increase, higher frequency of services would be possible, reducing cost and overall travel time. It is therefore important to make these solutions findable for expeditors for whom alternatives could be interesting but who are now solely relying on trucks, out of habit or because they lack visibility of these alternatives. In addition, also truck capacity on of-peak hours and intermediate storage nodes could also be increased. This allows for the remaining truck transports to be conducted outside peak hours in the most congested areas, while still arriving at (or leaving from) the cargo owners location during business hours.

The general user story could be formulated as follows

As a logistics company active in the Port of Antwerp, I want to better align with the planning of other stakeholders in the port to be able to work more efficient and more reliable.

For this use case 4 user stories are formulated from the viewpoint of four key business roles:

- Transport provider
- Node operator
- Expeditor
- Policy maker

2.1.1 User story 1: Intra port alternatives

As a (road)transport provider I want to avoid congestion inside the port so that my planning becomes more reliable.

The main road access to the Port of Antwerp is the highly congested Antwerp Ringway (R1 and R2). On some segments, delays occur almost around the clock. Additionally, the segments of the outer ringway (R1) between Kennedy tunnel and A12 and just before the E313 have the highest accident rate in the country, leading to a high unpredictability of traffic speed (Verkeersindicatoren.be, sd). Also, as maritime vessels become larger, peak pressure on the port and its hinterland increases. This leads to waiting times at the terminal and congestion on the roads inside and around the port. Combination of both types of delays can increase loading or unloading time drastically: if the predefined timeslot for (un)loading at port is missed due to traffic delay, additional waiting time is added until a new slot is available. Therefore, a more reliable solution is needed, especially for transports who need to cross the river Schelde, as they need to use one of the congested tunnel options.

For the transport provider picking up or dropping of a container at 'their' side of the river Schelde allows for a more accurate planning, with less overtime or late arrivals. On the downside, they would lose a small part of their work, namely the segment between the original drop-off or pick up (the gateway node) and the new drop-off or pick-up node (a hub at 'their' side of the river Schelde). This happens because an expeditor assigns this task to a different transport provider or because they arrange for a subcontractor to handle this leg themselves.

For a transport provider to accept this solution, it needs to:

- Reduce time spend in dropping of or picking up a container;
- Increase reliability of total trip time;
- Do the above to an extend that compensates for the loss of income due to another transport provider handling the leg between the gateway node and the hub node.

The transport provider needs to:

- Publish their capability to the network
- Answer capacity requests truthfully

2.1.2 User story 2: Next mode of transport

As a node operator I want to know the next transport modes so that I gain time to optimize my operations and reduce waiting times

Node operators, specifically terminal operators in the port (gateway nodes), indicate that they have limited visibility on when a container is going to picked up and by whom (which transport mode). The second question is already partly resolved by the introduction of the Certified Pick-Up system (CPU), which shares information on who is allowed to pick up a certain container. Further roll out of this system will increase the access of the terminal operators to this information. However, the question when a container is going to be picked up is not tackled by this solution and terminal operators are often only aware of this a day in advance, when a slot is booked (trucks) or a loading/unloading list is shared (for trains or barges).

If node operators know in advance not only who is going to pick up a container, but also when, yard planning and work schedule could be further optimised. This would not only benefit the terminal operator but might also allow for more efficient handling of trucks, trains and barges.

For a terminal operator to accept this solution, it needs to:

- Who is going to pick up a container and when;
- Allow for enough flexibility (possibility for them to change timeslots) to be able to handle the shifting schedules of maritime vessels.

The terminal operator needs to:

- Respect slots once booked and accepted

2.1.3 User story 3: Increase reliability of import moves

As an expeditor, I want to increase the reliability of my import moves, to optimise work schedules at the unloading location.

Expeditors are in charge of organising the move of a container from the port area to the hinterland unloading destination. They need to choose the most appropriate route for a container, depending on the needs of their clients (the cargo owner). Often, the known network from which they can choose an option is limited to a limited number of trucking companies. Trucks are relatively fast and flexible, but they are also relatively expensive (although less transhipment costs compensates for this on short distances) and have a high impact on society. Additionally, they can be unreliable in highly congested areas (as described in user story 1). At destination, work planning is often depended on the timely arrival of supplies. If a container arrives later than scheduled, this means there can be a delay in the entire work planning. Therefore, it can be more relevant to have a high reliability then to have the fastest delivery possible.

If an expeditor could have access to a full overview of the logistic network (within the relevant area boundaries), they could find alternative routes that might be more suited to their clients' priorities. This would allow them to select transport options with a lower impact on society, without compromising their own business.

For an expeditor to accept this solution, it needs to:

- Give a clear and reliable overview of potential routes;
- Include enough alternative transport providers and node operators in their area to generate relevant alternatives;
- Allow for individual preferences when selecting an optimal route;

The expeditor needs to:

- Enter an order with all relevant information into the system

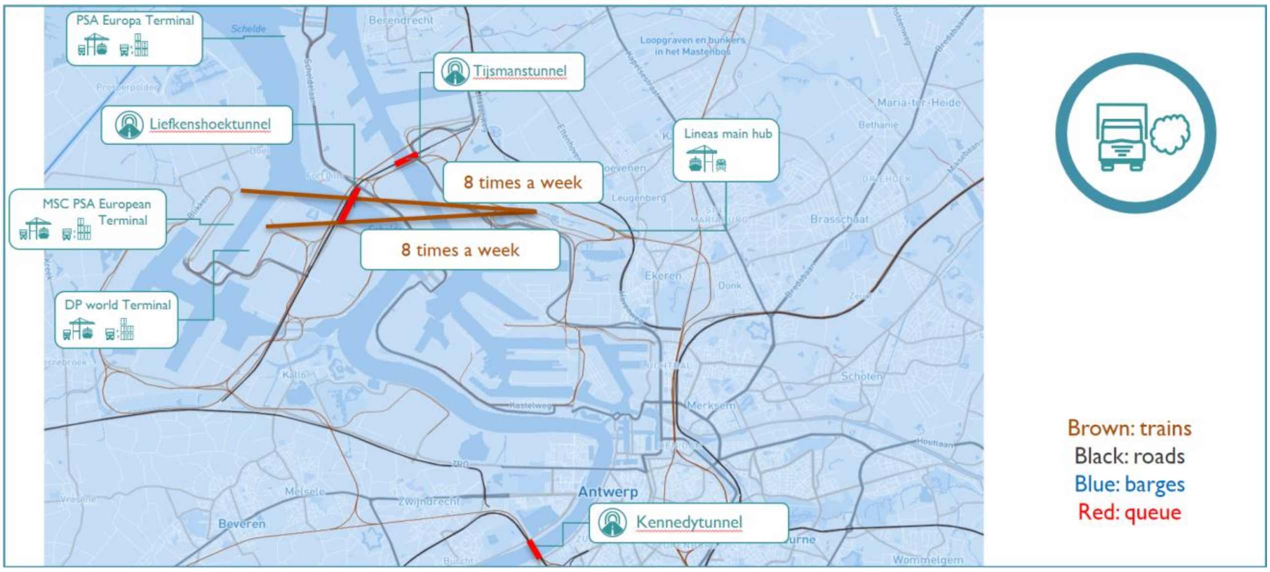

Figure 1: visualisation of the first user story of the first use case

2.1.4 User story 4: Optimization of flows

As a policy maker I want to optimize logistic flows so that external costs decrease.

Currently, truck is still the most popular mode of transport for containers entering or leaving the port of Antwerp[1]. Trucks do not only have a large impact on road congestion, however they also have a larger impact on other externalities, including CO², then trains or barges. If the government wants to adhere to its strategic long-term vision “In 2050” to “prioritise collective transports over individual transports” and to “reduce CO² emissions with 80 to 95% compared to 1990” a shift towards train and barge transport is necessary.

Figure 2: Congestion on Flemish roads

For a policy maker to accept this solution, it needs to:

- Give a clear indication to the user as to which option is most sustainable;
- Reduce the amount of tonkm by truck in favour of rail and barge;
- Include the possibility to keep track of total external costs per trip and/or per company.

A policy maker needs to:

- Provide a framework for measuring the sustainability of a trip

[1] One of the deepsea terminal operators in the advisory board reports 62% truck, 35% barge and 3% train between 20/02/2020 and 20/03/2020, import and export combined

2.2 Use case 2: reacting to disruptions

Even with impeccable planning, the logistics process remains vulnerable to small and larger ad-hoc disruptions. Not everything in the real world can be predicted long in advance, for example traffic jams due to accidents, technical malfunctions of infrastructure or equipment, floodings,… . These disruptions are often out of the control of the individual stakeholders and/or only appear late in the transport planning process. This necessitates the system to respond in real-time, while only limited real-time information is available. Solutions are therefore often suboptimal, adding to delays and costs.

Additionally, some optimisations can only be done in (near to) real time. Here, we focus mainly the filling up of empty return trips for trucks. But also train and barge slots can become available late in the process due to cancellations, or additional services can be proposed if a high demand is detected. Other optimisations could be triggered by a drop in price for a certain service (to fill up excess capacity for instance).

By increasing the visibility in the hinterland transport system, expeditors can be alerted to disruptions or optimisation opportunities in (near to) real time. This allows for them to evaluate the current plans in light of these events and consequently replan and rebook if necessary. The transporters and node operators would then automatically be notified of these changes (including any subcontractors unknown to the expeditor). They can then, in turn, adapt to these changes faster and in a more structured manner then they would have been able to without this visibility and automation.

The general user story could be formulated as follows

As a logistics related stakeholder in Flanders, I want to increase real-time visibility of the hinterland network, so I can better anticipate my route

For this use case 4 user stories are formulated from the viewpoint of four key business roles:

- Cargo owner
- Transport provider
- Expeditor
- Network manager

2.2.1 User story 1: Adapt to changing ETA

As a cargo owner I want to get an updated ETA so that I can optimize my flow of goods

The first user story takes the viewpoint of the cargo owner, depending on a certain cargo flow to receive or send out their goods in time. After the cargo owner has send out the order and accepted the expeditors proposal, the often don’t have any possibility to directly intervene when a disruption is happening. If some coordination is done, it is often done by phone or email, making it a time-consuming process sensitive to error. Optimisation of this process could therefore safe a lot of time and money.

This use case proposes an automated notification send to the appropriate parties as soon as the disruption occurs, which could save a lot of time. Depending on the situation, this notification can contain several possible actions for the cargo owner to take:

- Notification only: disruption doesn't push delivery time or cost beyond the cargo owners constraints;
- Adaption request: on-time delivery remains possible but requires changes to the cargo owners' priorities and/or constraints (e.g. Cost to high, prioritise speed over sustainability, split up shipment,…);
- Delay inevitable: cargo owner should adapt own operations to accommodate for late delivery/pick-up. Priorities and/or limitations for routing can be adapted.

For a cargo owner to accept this solution, it needs to:

- Give a complete and easy to read overview of all cargo en route;
- Include the possibility to create custom notifications;
- Include the possibility to create standard disruption responses.

The cargo owner needs to:

- Set a clear set of constraints
- Set a clear set of priorities

2.2.2 User story 2: Make free capacity findable

As a transport provider I want to make my free capacity findable so that I can reduce my empty kilometres.

The second user story takes the perspective of the transporter, who has free capacity available. In the current Business as Usual it is hard for an expeditor to find these free slots on trains, barges or trucks in real-time. On the one hand transport providers are reluctant to share this information, as it gives competitors insight into their business and can be used by expeditors to drive down the price. On the other hand, there is often no technical solution available to make this information available without significant manual inputs.

This use case proposes an integration between local capacity and route planning of the transport provider and the routing module. This allows for the routing module to find empty slots and propose optimisations. Further discussion is needed to fine tune how best to approach this. Following options could be considered:

- Integrating a 'share empty capacity' option, allowing the transport provider to actively share an empty slot, possibly including a 'push' message to other transport providers executing a trip on the same axis.
- Integrating a 'optimise routing' option in the expeditors system, allowing it to find transport providers already present at a specific location, sending them a notification questioning if capacity is available or not.

For a transport provider to accept this solution, it needs to:

- Guarantee the option to hide or show free capacity as desired
- Allow for a price negotiation between the transport providers offering and requesting the empty slot

The transport provider needs to:

- Make empty capacity visible to the network (to a certain degree)

2.2.3 User story 3: Adapt route selection

As an expeditor, I want to be able to keep track of changing conditions in the logistic network to be able to optimise my transport flows as much as possible.

Expeditors are responsible for planning the route of cargo, making sure it arrives at destination at the agreed time and/or below a set price. They are therefore always looking for possibilities to optimise routes as to offer better service to their clients (for which they are rewarded). On the other side, they are often confronted with disruptions in the logistic network, forcing them to adapt their initial plan and resort to a less optimal (often more expensive and/or slower) solution. This forces expeditors to plan either very robustly (I.e. allow for a lot of buffer times to accommodate for delays) or very agile (ie very quickly change plans) to ensure timely delivery.

For an expeditor to accept this solution, it needs to:

- Give a complete and easy to read overview of all cargo en route;
- Include the possibility to create custom notifications;
- Include the possibility to create standard disruption responses.
- Allow to find empty slots in (near to) real time

The expeditor needs to:

- Enter an order with all relevant information into the system
- Define responses to disruptions and/or optimisation potential

2.2.4 User story 4: Optimise infrastructure use

As an infrastructure manager, I want to be able to guide traffic flows to be able to make maximal use of capacity and reduce congestions to a minimum.

Governmental organisations in charge of the different networks (road, rail, water) are already working towards getting a better visibility of the flows moving on their network. For trains, visibility is very good, as all trains need to request a rail path to be allowed to use the network. For waterways, a similar system is deployed, where captains of inland vessels need to request a specific route, after which their passage at locks and bridges is handled faster. Tracking is done in real time through the River Information System (RIS). For road, no pre-request is needed, but the usage of the network can be collected afterwards, true the On Board Unit (OBU) used to collect data for the road pricing system.

All of these function well enough, but what is currently missing in these systems, is a possibility to alert (planned) users of (planned or last minute) disruptions on the network in an efficient way. The infrastructure managers can also use the historical data and planned routes available through PI to test several options for alternative routing after the disruption. They can then combine the disruption notification with suggestions for alternative routes. The chances of an expeditor or transport provider choosing a train or barge option as an alternative even after disruption increases.

For an infrastructure manager to use this solution, it needs to:

- Integrate with the existing systems to grant access rights and/or track movements;
- Efficiently send the information about disruptions to all users of the affected infrastructure;
- Return decisions made by the user after receiving these notifications to adapt access rights accordingly.

The infrastructure manager needs to:

- Monitor the state of the network
- Share disruption alerts
- Propose alternative routings if relevant

2.3 Use case 3: empty container flow optimization

As a container user, I want to better coordinate the flow and balance of my empty containers across the network so I can optimise my transport flow

The last use case is focussed on finding an empty container. Before shipping out (containerised) goods, an empty container needs to be secured. These containers are commonly owned by transport providers responsible for the main haulage. In the case of PILL these are maritime carriers. The first and last leg of any trip in containerised transport is therefore the pick-up and drop-off of an empty container at a depot, assigned by the container owner. These empty container movements can take up a significant portion of the hinterland trip and consequently of the (external and internal) costs. As the location of the depot is assigned by the container owner, and the selection of container owner is dependent on the selection of the transport provider for the main haulage, only limited optimisation is possible without their consent. Reuse of empty containers available at or nearby the shipper's location, would significantly reduce the empty container distance.

Today, container reuse options are available through several platforms, matching available empty containers with new loads. However, they don't have the possibility to predict the availability of or the need for containers. In addition, making these containers available for pickup is a manual process, meaning it takes up time and is prone to error. Therefore, this solution is not as efficient as it could be using PI.

In the current business, this case mainly relates to ISO-containers (20 or 40 ft) and (to a lesser extend) pallets. As the concept of Physical Internet spreads, a larger number of casings will be made standardized and reusable. This makes their return an important factor in the realisation of an efficient logistics system.

2.3.1 User story 1: Container reuse

As a cargo owner I want to check if reuse of an empty container is possible / profitable so that I can avoid unnecessary trips with empty containers

Cargo owners generally have a pretty good view on when they are going to need a container or when an empty container will be available at their site. However, as this information is not shared, nobody has an overview of when en where containers will be available or needed. It can even happen that a container at a relatively distant location is assigned to a cargo owner for a specific trip, while this cargo owner will have an empty container available at their own site at this time. As this information is unknown to the container owner, they cannot take this into account while assigning the container, which creates two unnecessary trips.

Within PI, the planning of a route is done more transparently, meaning that an overview can be generated of who will have a container and who will need a container in the near future. An optimisation step could be introduced redistributing the containers already in the vicinity, only getting new containers from a depot when the local need cannot be fulfilled locally.

2.3.2 User story 2: Container (re)positioning

As a hinterland terminal operator I want to check if empty containers will be available/needed so that I can balance my equipment

Hinterland node operators with depot capability are responsible for providing empty containers to cargo owners and accepting and checking empty returns. As they are often unaware of which type of container will be needed when, they can be obliged to go pick up an empty container at a larger depot last minute (and consequently, by truck) to accommodate for the needs of their clients.

If a local imbalance in the demand for containers could be detected in advance, node operators with depot capability could have empty containers shipped in by barge or train rather than by truck. As these barges or trains would be scheduled to arrive at their node anyway and these empty containers could fill up empty slots on these trips, both transport provider and node operator benefit from this arrangement.

3 Assumption mapping

The Physical Internet-blueprint solution will be based on the use cases and user stories defined above, in order to answer the critical challenges in the logistics industry. The PI-blueprint solution reasons from certain assumptions about the way it will need to work, provide value or answer stakeholders' needs, in order to fulfil the use cases.

Throughout the PILL project, the solution will be tested and validated. These assumptions form the basis of this testing and validation process. If we can confirm all our assumptions, we can consider the solution to answer the use cases and challenges, and to be a success.

Assumptions are based on stakeholder interviews, literature reviews and expectations stated in Letters of Intent by the Advisory Board.

Assumptions are divided over 3 categories: Desirability, Feasibility and viability

Desirability:
Are we solving the right pain?

- Who is the target customer?
- What challenges/needs to they have?
- What jobs do they try to complete?
- What is the outcome the customer wants to achieve?

Feasibility
Can the technology be built to achieve our desired goal?

- How does the solution integrate in the current logistics process?
- What are the biggest technical and engineering issues?
- What are the legal and regulatory risks?

Viability:
Does our solution contribute to an improved business strategy?

- How will companies profit from our solution?
- How is cost and pricing determined?
- How do companies generate revenue?

3.1 Key stakeholders

Overall view of the key stakeholders, their needs and jobs-to-be-done within the different use cases (for more details see Chapter 2.2 Stakeholder mapping).

Stakeholders	Jobs to be done	Needs
Logistic roles		
Cargo owner	- Create an order - Set priorities (speed, cost, reliability & emissions requirements,…) - Pay for transport	- Get cargo from point A to B - Have sufficient empty containers available for transport - Reliable flow of goods
Expeditor	- Plan and coordinate the end-to-end trip of the cargo, containing several legs of transport - Define reaction to disruptions	- Ensure a reliable ETA for the cargo owner - Get a clear overview of the available network/routing options - Get updates on ETA from transporters
Transporter	- Organise transport of the individual leg - Set schedules for scheduled movers	- Receive container and container information in time - Be aware of upcoming disruptions - Fill up empty capacity
Node Operators	- Plan and handle loading and unloading of containers - Store (full and empty) containers	- Information on when en how (transport mode) a container will arrive and leave
Policy roles		
Infrastructure manager	- Guide traffic flow - Manage infrastructure quality - Communicate general disruptions	- Overview of planned trips on the network
Policy maker	- Set general rules of conduct - Guard societal interests	- Reduce external costs from congestion

Table 3: Key stakeholders of our use cases

3.2 Overview assumptions

The tables below give an overview of all assumptions that were identified during the definition of the usecases. All of these are defined by:

- The business role for whom they are relevant
- Their importance to the use cases (1 low importance to 5 high importance)
- Their uncertainty at this point in time (1 low uncertainty to 5 high uncertainty)
- The challenge (and related use case) for which they are relevant.

Desirability Business role	Assumption	Importance (on 5)	Uncertainty (on 5)	Wicked Problem
All logistics roles	want to improve their planning (predictability)	**5**	3	1
All logistics roles	Want to decrease the (unpredictable) delays in logistics Specifically: they want to decrease time waiting for a slot at the terminal and time lost in traffic jams	5	1	2
Cargo Owners	want to increase their view of possible transporters to find solutions that better fit their priorities	4	4	1
Cargo Owners	want to know were their (valuable) cargo is and who is responsible for it, so they know who is accountable in case of dammage or delay	3	2	2
Expeditors	want to increase the reliability of their transports Specifically: current congestion at the terminals and on the road system creates high variability in transport time, increasing the probability of late delivery.	4	4	2
Expeditors	Want to increase the overall sustainability of their logistic chain.	3	3	1,2,3
Expeditors	Want to get notified in case of disruptions	2	4	2
Expeditors	Want to know the priorities of each order	2	4	1
Transporter	Want to avoid idle time	3	1	1,2
Transporter	Want to improve the fill rate of their movers	4	1	1

	Specifically: Lineas wants to increase the fill rate of the terminal -> Lineas main hub movement			
Transporter	want to reduce the buffer time needed when planning their transports and/or want to reduce the amount of overtime caused by unexpected delays during transport Specifically: current congestion at the terminals and on the road system creates high variability in transport time. This requires large buffers when planning personel and assets.	4	4	1
Transporter	Barge & train operators want to become more competitive by using their economies of scale	5	1	1
Transporter	Want to make reservations (given all of them can be done through one platform) rather then wait for an available slot on site	4	4	1
Transporters	Want to optimise their free capacity	5	1	1
Node Operators	want to make their yard planning as efficient as possible.	2	1	1
Node Operators	want to plan their work schedules as efficient as possible.	2	1	1
Infrastructure Manager	Infrastructure managers want to improve infrastructure maintenance planning to lower congestion costs	3	3	1
Policy Makers	Policy makers want to reduce the overall external costs of logistics	5	1	1

Table 4: Desirability assumptions

Feasibility Business role	Assumption	Importance (on 5)	Uncertainty (on 5)	Wicked Problem
Node operators	Routes can be generated between nodes	5	3	1
Node operators	Administration to accept additional transhipment between unknown entities can be minimal (to make it worth their while)	3	2	1,2
Transporter	Administration to accept additional load from unknown entity can be minimal (to make it worth their while)	3	2	1,2
Infrastructure manager	Infrastructure manager can share the (future) state of the network to allow for accurate planning	3	2	1
All logistics roles	The PI solution is technology agnostic, meaning all logistics companies can integrate with it	5	3	1,2,3
All logistics roles	All stakeholders in the network have access to an updated list of each other's business information and capabilities in order to calculate routes	5	4	1,2,3
All logistics roles	Billing can be done in an efficient and transparent way.	3	5	1,2
All logistics roles	Data collection needed to predict the future network state can be done without installing (much) extra sensors	4	2	1,2,3
Policy makers	Connection to relevant governmental organisations should be made possible to reduce administrative burden	2	3	1,2,3
All logistics roles	Different rights have to be given to different (groups off) stakeholders for all to have sufficient access in a privacy sensitive manner	3	2	1,2,3
Transport providers	Need to digitalize (part of) their planning process to be able to interact with the PI	4	1	1
N/A	Relevant alternative routes can be found already with a limited # of parties that join the system	5	3	1
N/A	Stakeholders in the network can interact with each other to plan or alter routes	5	3	1,2,3
N/A	Interaction between stakeholders can be automated	4	5	1,2,3

Feasibility Business role	Assumption	Importance (on 5)	Uncertainty (on 5)	Wicked Problem
N/A	Capacity data can automatically be pulled from transport providers	3	4	1,2,3
N/A	Routes can be compared on parameters such as time, emissions and reliability (optional cost)	4	4	1,2,3
N/A	Routing software can create optimised mulitmodal route options with the available data	5	4	1

Table 5: Feasibility assumptions

Viability Business role	Assumption	Importance (on 5)	Uncertainty (on 5)	Wicked Problem
All logistics roles	Logistics companies will want to handle payments through the PI-system, rather than 1on1 outside the system	3	4	1
All logistics roles	The solution will offer an easy to use and transparent billing system	3	4	1
All logistics roles	Logistics companies will accept integration costs to integrate with the PI-system	5	4	1,2,3
All logistics roles	The solution will result in more reliable transport that reduces the cost of delays or disruptions	5	4	2
All logistics roles	All players are willing to share the relevant data with the network	5	4	1,2,3
All logistics roles	The solution can work without compromising commercially sensitive data	5	4	1,2,3
All logistics roles	The solution will follow a set of rules that leads to a better flow, compared to the BAU	5	3	1,2,3
Expeditors	The solution will reduce the cost of the overall logistics process by optimising the planning process	5	4	1
Expeditors	The solution will reduce the cost of disruptions by rerouting transport when a disruption occurs	3	5	2
Expeditors	The solution will reduce the personnel cost related to planning	3	2	1
Expeditors	The solution will make it easier for expeditors to select the more optimum route for their preferences (time, reliability, cost, emissions)	4	4	1
Expeditor	The solution is capable to increase the number of potential routes to choose from	5	2	1
Transporter	The solution will increase the # of transport orders for smaller operators	2	4	1
Transporter	The solution will increase the fill rate of movers	4	3	1
Transporter	The solution will shorten the total time at port	3	3	1,2

Viability Business role	Assumption	Importance (on 5)	Uncertainty (on 5)	Wicked Problem
Transporter	Transport providers will be able to compare the total cost (internal and external) of different solutions (should I do this myself or should I subcontract?)	3	4	1
Policy makers	The solutions will result in streamlined procedures that lower the costs of administration and controls	3	4	2
Policy makers	Policy makers can use the solution to create short term and long term simulations to use as a basis for policy making	2	4	1
Policy makers	The solution will result in a reduced CO2 logistics process	5	3	1,2 ,3

Table 6: Viability assumptions

4 Conclusions

4.1 Focus of the PI-solution

At the beginning of this chapter, we explained 3 key Wicked Problems (WP's) in the logistics sector that will be addressed in the PI-blueprint solution through the use cases. These 3 Wicked Problems can be considered appearing in a chronological order: first the challenge of improving planning reliability before a transport, next increasing resilience against disruptions during the transport and lastly optimising future logistics processes.

When scoring our solution assumptions, we notice this chronological order recurring as well in the importance of assumptions. Assumptions that relate to planning overall have a higher perceived importance (by stakeholders) than assumptions to resilience or future optimisations (the latter which has the lowest). This is not only true for the perceived need or business perception, but also from a technical standpoint. Being able to align planning (WP 1) is needed to reroute a shipment in real-time during or right before a disruption (WP2), as well as to optimise future planning processes (WP 3)

We can conclude that improving planning reliability (WP 1) is the most critical aspect of our solution, and with it the capability to generate and compare route options based on information shared by the network. Consequently, this problem and its related use case and stories will be the main focus of the development and testing of the PI-blueprint.

Considering the importance score for the 3 Wicked Problems, the first version of the PI-blueprint will focus on Wicked Problems 1 and 2 (planning optimisation + resilience against disruption), with WP 1 being the priority. WP 3 (future planning) will be disregarded in the first version of the PI-blueprint, with the assumption that this problem will rely heavily on the outcome of the first two challenges. This problem will be developed in a later phase of the project or in follow-up projects.

Table 7: Summary of key assumptions (importance score = 5)

Parameter	Assumption	Wicked Problem
Desirability	All logistics roles want to improve their planning	1
Desirability	All logistics roles want to decrease the (unpredictable) delays in logistics	2
Desirability	Barge & train operators want to become more competitive by using their economies of scale	1
Desirability	All logistics roles want to optimise their free capacity	1
Desirability	Policy makers want to reduce the overall external costs of logistics	1
Feasibility	Routes can be generated between nodes	1

Parameter	Assumption	Wicked Problem
Feasibility	The PI solution is technology agnostic, meaning all logistics companies can integrate with it	1,2,3
Feasibility	Relevant alternative routes can be found already with a limited # of parties that join the system	1
Feasibility	Routing software can create optimised, multimodal route options with the available data	1
Feasibility	All stakeholders in the network have access to an updated list of each other's business information and capabilities in order to calculate routes	1,2,3
Feasibility	Stakeholders in the network can interact with each other to plan or alter routes	1,2,3
Feasibility	Interaction between stakeholders can be automated	1,2,3
Viability	Logistics companies will accept integration costs to integrate with the PI-system	1,2,3
Viability	The solution will result in more reliable transport that reduces the cost of delays or disruptions	2
Viability	All players are willing to share the relevant data with the network	1,2,3
Viability	The solution can work without compromising commercially sensitive data	1,2,3
Viability	The solution is capable to increase the number of potential routes to choose from	1
Viability	The solution will reduce the cost of the overall logistics process by optimising the planning process	1
Viability	The solution will follow a set of rules that leads to a better flow, compared to the BAU	1,2,3
Viability	The solution will result in a reduced CO2 logistics process	1,2,3

4.2 Key challenges

Reviewing the most important assumptions that determine the success of our solution (see table 8), we can determine our key challenges in creating the Solution, which are focussed on solving the Wicked Problem 1. These challenges will be the basis of the future stages of this project, and the development and testing of the PI-blueprint.

The key challenges can be defined and categorised as follows:

Table 8: Research questions and key challenges

Category	Data Sharing	Perceived Business value	Decision making (ABM)
Research question	How can the necessary data be shared without infringing commercial privacy?	What business value can the PI create while respecting the commercial privacy and individual interests of each actor.	How can ABM contribute to evaluate the impact of implementation details (regarding disruptions, routing algorithm rules, policies...)
Key challenges: How might we...	Connect stakeholders with each other (F) Share stakeholder data across the network? (F) Share data without infringing stakeholders' commercial privacy (V) Minimise data sharing requirements to generate sufficient route options? (V)	Create interoperability between stakeholders to plan routes? (V) Automate the planning, booking and payment processes? (V) Offer commercial value for all stakeholder groups? (D)	Determine the unique roles in the transport chain that need to be planned? (F) Use the ABM to determine the PI internal rules that lead to improved logistics planning and flow? (D) Use the ABM to determine the PI internal rules that lead to optimally handling disruption? (D) Compare route options based on price, cost, ETA and reliability (D)

These research questions aling with the research questions defined in chapter 1 PI benefits