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NOVIMAR
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CONTENTS

List of symbols and abbreviations

BM	Business Model
FV	Follower Vessel
FVO	Follower Vessel Owner
IT	Information Technology
IWT	Inland Waterway Transport
Kn	Knot or one nautical mile per hour (1.852 km/h)
LV	Leader Vessel
LVO	Leader Vessel Owner
MMMS	MIXMOVE Match Solution
Nm	Nautical miles
PI	Performance Indicator
RoRo	Roll on Roll off
TC	Transportation Cost
TLC	Total Logistic Cost
ToR	Terms of Reference
VO	Vessel Owner
VT	Vessel Train
VTO	Vessel Train owner

1 EXECUTIVE SUMMARY

This deliverable provides the main output of work done for task 2.3 in WP2 of the Novimar project. In this report the business models for the VT are developed along with the first developments of the cargo consolidation capabilities in ports.

For the development of the business models first an extensive literature search has been done of existing business models in other transport sectors. Based on that four initial VT business models were developed. These initial business models were then further validated by IWT, short Sea and logistics experts (both from project partners as from other experts outside the project). Based on these insights and expertise two initial business models are identified which will be further researched in the remainder of this project. These business models will also be included in the transport model as stated in D.2.2 Construction and validation of the NOVIMAR transport model. Based on the developed business models also the operational issues and the initial VT variants are determined.

In order to exploit the flexibility offered by the vessel train concept, the organization of cargo handling in deepsea ports also needs to be adjusted. Therefore the operations need to change in such a way that cargo shall not have to unnecessarily wait for other cargo to be loaded or unloaded. To achieve this, a special consolidation (or sorting) process is needed in loading ports, such that “all cargo in one vessel has the same discharge port. The terms of reference of this consolidation have been developed in this deliverable. These terms of reference are determined for the port of loading, joining the vessel train and the vessel train operations, while no special capabilities are required to support activities in the port of discharge.

By the end of 2019 the Marlo IT-Tool will be fully developed based on these terms of reference.

1.1 Problem definition

One of the main issues that needs to be developed for the VT is the business model of the VT. The business model will determined how the VT can create value for both the VT operators, the VT users (FV) and the cargo owners (ultimate users of the VT). These business models will also determine to a very large extent what the operational issues of the VT will be and what the initial VT variations will be which will be researched in the main “Antwerp case study”.

Next to that, also the cargo consolidation in sea ports needs to be developed. As described in D.2.2 this cargo consolidation could help to improve the effectiveness of the VT concept.

1.2 Technical approach and work plan

In this task there are two main objectives:

- To develop the VT transport system: business models, operations and different variants.
- To develop effective cargo consolidation capabilities in ports

The first one relates to the operational aspects of the VT in a transport/logistics environment. Here the different VT-variants are obtained by combining vessel sizes, vessel types, cargo types and number of vessels in a VT[1].

The second main objective relates to the cargo consolidation capabilities in ports. This objective is a prerequisite for VT-efficiency requiring that "all" cargo on-board a specific vessel need to have the same discharge port. To achieve this it is necessary to:

- Identify all incoming load units, regardless of origin and incoming transport mode and their destinations
- Sort cargo such that all arriving cargo with the same discharge port (derived from destination or given by the transport management system used to manage the door-to-door operations) is stored together in the port of departure, preferably such that loading operations are very efficient.
- Assign cargo to a specific vessel, matching the amount of cargo destined for a specific discharge port with the capacity of available vessels, to ensure the best possible utilisation of resources. An existing tool, the Marlo IT tool[2] dealing with parcels cargo consolidation, will be extended to deal with containers and trailers. The modified tool will not impact on existing port terminal management systems.

In this deliverable there are two adjustments made. The first adjustment in this deliverable is the change in due date for task 2.3.5. Task 2.3.5 took more time than anticipated when the project plan was drafted. Task 2.3.5 is the detailed description of how the Marlo IT tool will be changed according to the specification drafted in task 2.3.4. For the development of the VT transport model the information of T.2.3.4 can be integrated. How the software should be changed (T.2.3.5) is for the transport model less relevant. Therefore a revised version of deliverable D.2.3 will be developed, which will include the detailed description of the adjustments made to the Marlo IT-Tool. The due date for this deliverable is the end of 2019.

The second, small adjustment is the change in work sequence for the tasks related to the Development of the transport system. We started with the further development of the initial business models. From these business models the operational implications can also be determined. Based on these outcomes the initial VT-variants will be determined.

The output of this deliverable will be used in the transport model which was developed in D.2.2.

1.3 Results

This deliverable provides the main output of work done for task 2.3 in WP2 of the Novimar project. In this report the business models for the VT are developed along with the first developments of the cargo consolidation capabilities in ports.

[1] see WP1 task T1.1

[2] The Marlo IT software as a service application is currently being used to consolidate (reconstruct) orders for companies like 3M and l'Oreal.

A long list of 4 initial VT business models were developed. These initial business models were then further validated by IWT, short Sea and logistics experts. Based on these insights and expertise two initial business models are identified which will be further researched in the remainder of this project. These business models will also be included in the transport model as stated in D.2.2. Based on the developed business models, the operational issues and the initial VT variants are determined. Moreover, the terms of reference related to the cargo consolidation is developed.

The outcome of this deliverable is the development of two possible business models of the VT. These business models will determine the operational issues of the VT and the initial VT variations, which will be researched in the main “Antwerp case study”. These results match with the set objectives of this deliverable.

Next to that, also the cargo consolidation in sea ports needs to be developed. As described in D.2.2 this cargo consolidation could help to improve the effectiveness of the VT concept. This result partly match with the set objectives of this deliverable. The main development of the Marlo IT-tool for which the terms of reference are developed, are to be finalized at the end of 2019.

1.4 Conclusions and recommendation

The developed output of this deliverable gives the description of the two business models that might be used to set up the VT. These two business models will be included in the transport model developed in D.2.2. These two busies models are:

- BM3: Liner (one shipping company owning all the fleet)
- BM4: Digital platform business model

These business model differ in a fundamental way. In the liner option there is only major player who is organizing the VT using its owns vessels, while in the digital platform model a more Uber type of business model is developed. In the latter, different vessel owners can join the VT. These different business models will also give different operational issues. And each of these business models will have different initial VT variants.

The terms of reference for cargo consolidation are determined for the port of loading, joining the vessel train and the vessel train operations, while no special capabilities are required to support activities in the port of discharge. Based on these terms of reference the full Marlo –IT tool can be developed. The working principle of the Marlo – IT tool can be implemented in the transport model (a reduction in waiting time for both vessels and cargo in deepsea ports).

In this deliverable one corrective measure was taken. This was the change in due date for the full development of the Marlo-IT tool. Changing this due date will not impact the work in this or other WPs. This is due to the fact that in the transport model the effect of the Marlo –IT tool will be taken into account (less waiting time for cargo that will be shipped with inland vessels). The way how is for the transport model, developed in D.2.2, less relevant.

2 INTRODUCTION

2.1 Task/Sub-task text

The main task objectives are:

- To develop the VT transport system: variants, operations, business models
- To develop effective cargo consolidation capabilities in ports

Envisaged activities:

- Sub-task T2.3.1: Determine initial VT-variants focusing on the container market in IWT, Short Sea Shipping (SSS) and the trailer/RORO market for sea-river vessels.
- Sub-task T2.3.2: Define VT-operational issues: operators (existing or a new type of stakeholder), scheduled versus non-scheduled services, service frequencies required to compete with land-based transport, information exchange between follower vessels - lead vessel on location and time to join or leave the VT.
- Sub-task 2.3.3: Identify VT business model options: distribution of operational costs between vessel owners within a VT, cost to join a VT, charges to pay by VT's to infrastructure stakeholders (locks, pilots, etc.).
- Sub-task T2.3.4: Define Terms of Reference (ToR) for cargo consolidation capabilities in ports
- Sub-task T2.3.5: Modify and test the Marlo IT-Tool
- Sub-task T2.3.6: Prepare the task deliverable.

2.2 Analysis

The NOVIMAR project researches the VT, a waterborne platooning concept featuring a manned lead ship and a number of follower ships that follow at close distance by automatic control. In D.2.2 the main outline of the transport model has been developed. In this deliverable the operational aspects of the VT will be developed, along with a method for cargo consolidation which could improve the VT-efficiency.

2.3 Approach

Task 2.3 is the third task in Work Package (WP) 2 'Transport system model'. It started in month twelve of the project and runs until month twenty four. The deliverable is due end of month twenty three.

The basic work consists of desk research and modelling. The work was distributed according to the sub-tasks to different partners.

The output of this deliverable will be included in the transport model which has been developed in D.2.2.

3 PLAN

The objective of this deliverable is to further develop the VT transport system for an operational point of view. Next to that also effective cargo consolidation capabilities in ports will be developed.

3.1 Objectives

In this task there are two main objectives:

- To develop the VT transport system: business models, operations and different variants.
- To develop effective cargo consolidation capabilities in ports

The first one relates to the operational aspects of the VT in a transport/logistics environment. Here the different VT-variants are obtained by combining vessel sizes, vessel types, cargo types and number of vessels in a VT[3].

The second main objective relates to the cargo consolidation capabilities in ports. This objective is a prerequisite for VT-efficiency requiring that “all” cargo on-board a specific vessel need to have the same discharge port. To achieve this it is necessary to:

- Identify all incoming load units, regardless of origin and incoming transport mode and their destinations
- Sort cargo such that all arriving cargo with the same discharge port (derived from destination or given by the transport management system used to manage the door-to-door operations) is stored together in the port of departure, preferably such that loading operations are very efficient.
- Assign cargo to a specific vessel, matching the amount of cargo destined for a specific discharge port with the capacity of available vessels, to ensure the best possible utilisation of resources. An existing tool, the Marlo IT tool[4] dealing with parcels cargo consolidation, will be extended to deal with containers and trailers. The modified tool will not impact on existing port terminal management systems.

3.2 Planned activities

The planned activities of this deliverable are:

- **Development of the transport system: business models, operations and variants**
    - Identify VT business model options: distribution of operational costs between vessel owners within a VT, cost to join a VT, charges to pay by VT’s to infrastructure stakeholders (locks, pilots, etc.) (T.2.3.3).
    - Define VT-operational issues: operators (existing or a new type of stakeholder), scheduled versus non-scheduled services, service frequencies required to compete

[3] see WP1 task T1.1

[4] The Marlo IT software as a service application is currently being used to consolidate (reconstruct) orders for companies like 3M and l’Oreal.

with land-based transport, information exchange between follower vessels - lead vessel on location and time to join or leave the VT (T.2.3.2), assessment of morning a FV in a port.

  - Determine initial VT-variants focusing on the container market in IWT, Short Sea Shipping (SSS) and the trailer/RORO market for sea-river vessels (T.2.3.1).

- **Effective cargo consolidation capabilities in ports**
  - Define Terms of Reference (ToR) for cargo consolidation capabilities in ports (T.2.3.4)
  - Modify and test the Marlo IT-Tool according to the ToR from sub-task T2.3.4 (T.2.3.5)

3.3 Resources and involved partners

The distribution of the activities among partners in Task 2.3 are as follows:

TUD (leader) with UANTW, DST and MARLO determine the VT-variants, operational issues and business models. VML, PLIMS, TRB and DUISP assist with expertise from the own operational practice.

MARLO together with TUD and VML[5] define the ToR for cargo consolidation capabilities and for the tool. MARLO adapts the own Marlo IT Tool according to the ToR and tests the modified model.

3.4 Timeline

According to the Description of Action (DoA), Task 2.3 starts at month twelve and ends with deliverable 2.3 at month twenty four. The development of the content of the first version of this deliverable was finished at project month twenty three.

[5] Given the tragic death of Dennie Lockefeer the role of VMG was limited.

4 PLAN EXECUTION

4.1 Introduction

In this section, the short description of the planned activities of deliverable 2.3 are given, along with the deviations of that plan.

4.2 Performed activities

In order to develop the content of the first part of deliverable 2.3 the choice has been made to reverse the sequence of the envisaged tasks. Therefore we start with the further development of the initial business models. From these business models also the operational implications can be determined. Based on these outcomes the initial VT-variants will be determined.

Development of the transport system

Sub-task 2.3.3

The third sub-task of this deliverable will identify VT business model options. This will include the distribution of operational costs between vessel owners within a VT, cost to join a VT, charges to pay by VT's to infrastructure stakeholders (fairway dues). The first version of the business models have already been developed in D.2.2. In this task the business models will be further developed (more details). Also a bigger validity check (more interviews) of the business model will be done compared to what has been done in D.2.2. Based on the initial developed business models and the data collected from the interviews a full business model canvas will be developed.

Sub-task T2.3.2

Sub task 2.3.3 will research the VT-operational issues. This task will deal with the definition of the VT operators (existing or a new type of stakeholder), scheduled versus non-scheduled services, service frequencies required to compete with land-based transport, information exchange between follower vessels - lead vessel on location and time to join or leave the VT. In this sub tasks also the interaction between the FV leaving the VT and sailing to an (inland) terminal are researched. Also the mooring aspects of FV in a port is researched.

Sub-task T2.3.1

In the first sub task different VT options/types are developed. These VT options/variants will include combination of vessels types, the combination of cargo types and the type and number of vessels in the VT. These will be applied for the IWT and short sea container market, while for the sea river option the focus will be RoRo/trailer market.

Development for effective cargo consolidation capabilities in ports

Sub-task T2.3.4

Define Terms of Reference (ToR) for cargo consolidation capabilities in ports

Sub-task T2.3.5

Modify and test the Marlo IT tool according to the ToR from sub-task T2.3.4

Preparing the task deliverable

Sub-task T2.3.6

In this sub-task, the project deliverable will be developed.

4.3 Deviations from the plan

The first adjustment in this deliverable is the change in due date for task 2.3.5. Task 2.3.5 took more time than anticipated when the project plan was drafted. Task 2.3.5 is the detailed description of HOW the Marlo IT tool will be changed according to the specification drafted in task 2.3.4. For the development of the VT transport model the information of T.2.3.4 can be integrated. How the software should be changed (T.2.3.5) is for the transport model less relevant. Therefore a revised version of deliverable D.2.3 will be developed, which will include the detailed description of the adjustments made to the Marlo IT-Tool. The due date for this deliverable is the end of 2019.

The second, small adjustment is the change in work sequence for the tasks related to the Development of the transport system. We started with the further development of the initial business models. From these business models also the operational implications can be determined. Based on these outcomes the initial VT-variants will be determined.

5 RESULTS

5.1 Introduction

In this chapter the concise information regarding this deliverable is given. This chapter is structured in two main block. firstly, the development of the transport system is given, while in the second part the developments related to the cargo consolidation are given.

5.2 Development of the transport system

This sub-section is split into 4 smaller section. This first section deals with the general introduction of the development of the transport system and it will give the main work plan that has been followed. Next to that all the results of the three different subtasks are given.

5.2.1 Introduction

To development of the business models is done with in a four-step approach. In the first step a literature review is done to get an overview of the different business models of other transport modes. Based on this overview, the lessons learnt can be determined. In the second step the initial business models, which were developed in D.2.2, are further developed in an internal WP2 work shop in Duisburg. In this work shop the initial 4 versions of the BM are developed. In the third step, these initial outputs were then validated by consulting different stakeholders, both in and outside of the Novimar consortium. The 13 stakeholders that were contacted are:

- Vessel owners
    - Inland
    - Short sea
- Freight brokers
- Intermodal logistics service providers
- Freight forwarder
- Waterway authority

Based on the comments and suggestions of the different stakeholders, in the fourth step, the most promising business models (full development of the BM canvas) and operational aspects of the VT are determined. In section 5.2.2 the content related to the development of the business models are given, while in section 5.2.3 the operational issues of the VT are given. Section 5.2.4 deals with the initial first VT variant that will be researched. These initial variants will be inspirited by the developed business cases and by the operational implications of those business cases.

5.2.2 Results sub-task 2.3.3 (Development of the VT business models)

5.2.2.1 Taking lessons from BMs of other modes (step 1)

Table 1 gives the overview of the three initially developed BMs (Hoyer et al., 2017). For each of these three BMs one or more business models of other transport modes are proposed that can be used so as to take lessons for the development of the BM of the VT. For the BM1 of a dedicated shipping company as the VTO lessons are learnt from the 1) truck platooning, 2) airlines and 3) rail BMs, because the VTO is part of the company and thus lessons can be learnt from any type of company (except uber). For the BM2, which is based on the logic that the VTO is a third party (that is not part of the shipping company, thus being an intermediary party), third party logistics service providers (3PLS) are used for lessons to be learnt. Lastly, for BM3, the 'Uber' service, will be inspired by actual Uber case to take lessons learnt.

Table 1: Description of the three initially general developed BMs and logical link with the modes from which lessons can be learnt with respect to their BMs.

BM no.	BM 1	BM 2	BM 3
Descriptive title of the BM	Dedicated shipping company as a VTO	Third party shipping company	Uber
Type of service	Liner	Liner	Tramp
Type of LV	Dedicated or cargo	Dedicated or cargo	cargo
VTO	3PLS	A large shipping company	3PLS
Transport modes whose BMs are checked for lessons to be learnt	Since the VTO is part of the company, then lessons can be learnt from any type of company (except uber): **Truck platooning** **Airlines** **Rail**	Since this BM is based on the logic that the VTO is a third party that is not part of the shipping company, thus being an intermediary party, **third party logistics service providers (3PLS)** are used for lessons to be learnt. A VTO is the actor that brings together the FVs behind the LV and should be an actor that has the knowledge of bringing cargo together (see D2.2). This is the reason why 3PLS are used for further elaborating this BM.	Since this BM is a demand based BM, inspired by **uber**, the BMs of Uber itself are used to take lessons learnt.
Reality check (based on workshops organized by PLIMS in 2017)	The furthest from reality.	Close to reality because the VTO is an independent company and not part of a big shipping company.	The closest to reality because the model does not work if the FV has to wait for the VT.

Source: Authors' composition, based also on the D2.1

Before we continue presenting each of the BMs of the other modes and analyzing the extent of applicability (if any) to the VT concept, it is considered good that a definition of the BM is provided that will be used in the present task, since several definitions can be found in literature. In the present study, the definition of Demil and Lecocq (2010) is used that says that the BM concept refers to *"components or 'building blocks' to produce a proposition that can generate value for consumers and thus for the organization".* Therefore, one of the main questions/elements that is addressed by the BMs is how to generate revenues (Giesen et al., 2010) or how to make profit (Sinfield et al., 2012). And this is also one of the main questions that we want to reply for the VT concept? How to make the VT project generate revenues and thus be economically profitable?

Taking lessons from the main BMs of 3PLS[6]

Let's assume that we are a third party service VT organizer, which means that we are not part of a shipping company but independent. Thus, we are in charge of forming the VT or in other words in charge of finding vessels for the VT.

- The **Broker model** would be applicable to the VT only in the case the VT organizer provides also additional transport services apart from the service of organizing the VT. In this case, in which the VTO operates also as 3PLS or freight forwarder and not only as a VTO organizer, in this case, the Broker model could be used. The VTO would buy some shipment space from the vessel owners and would sell it back to the cargo owners with a markup. Thus, a better price could be achieved for the cargo owners than the price that they would pay if they would not use the VTO as intermediary actor but they would book themselves. This better price could be achieved either thanks to economies of scale, since the VTO will be able to purchase big amounts of cargo spaces at once (even in the case that there are small vessels, the VTO buys space from many vessels at the same time) or a lower price could be achieved thanks to the expected lower cost of travelling as part of the VT, since the operational costs (less crew) and also waiting times would be reduced, thus reducing the total transportation cost and as a consequence reducing the price that the cargo owner should pay to transport his/her goods.
- The **BM2-Gainsharing BM** could be applicable again when VTO plays the role of a 3PL or freight forwarder and the cargo owners go to the VTO and say that normally they pay e.g. 10 dollars per unit to be shipped and the VTO offers to transfer it for e.g. 8 dollars. This gain is again thanks to the reduced operational costs achieved from the VT. Additional further deals that could benefit the cargo owner, could be provided to him/her in the case that finally the delivery of the goods was made at a lower cost (thanks to more vessels finally being included in the VT, thus reducing the cost per vessel and thus the fee for the cargo owner as well).
- The **BM3- the commission model**, the VTO would work for the shipping companies (vessel owners) and would act as the intermediary person connecting them with the buyers, the cargo owners; thus making use of a standard commission-based system.

Source: (website amstan.com)

[6] Sub-scenarios of the original main BM2: Perspective of the cargo owner.

These sub-scenarios similarly to the aforementioned ones consider the VTO as a 3PLS. These scenarios that view the VTO as 3PLS that additionally to each initial transport services provided also provides the additional service of the organization of the VT might facilitate any difficulties that may arise for new entries in the market of independent actors. However, at this point it needs to be pointed out that these are not monopolistic scenarios and that there is not an intention of abusing the market. Thus, there are free possible entries to the market for everyone.

The applicability of the 4BMs of Hofmaan and Osterwalder (2017) into the VT concept is presented below:

- The **BM1 of a standard regional 3PLS** would be applicable for the VT concept, if the VTO plays also the role of a 3PLS and thus it will offer a short haul transportation and transportation management services within certain regions, warehousing and inventory management plus the organization of the VT.
- The **BM2 of niche service specialists** would be applicable for the VT concept, if the VTO plays also the role of a 3PLS similar to the one presented in the BM1, in the sense that it provides the same services with the difference that it also provides additional services based on their specialized knowledge for customers. This BM is applicable for small 3PLS operating on a regional level.
- The **BM3 of standard international 3PLS** would be applicable for the VT concept, if the VTO plays also the role of a 3PLS of a medium or large size, acting on an international level, providing long haul transportation, warehousing and inventory services and also provides different modes of transportation.
- The **BM4 of international service specialists** would be applicable for the VT concept, if the VTO plays also the role of a 3PLS with similar characteristics with the BM3 but with a larger variety of additional (tailored) services. The BM4 is the most complex 3PLS BM. Therefore, we can conclude that depending on the type of the required transportation services asked by a cargo owner, either being ‘regional or international’ or ‘standard or more specialized’, the VTO organizer/ 3PLS could use one of the four BMs of Hofmaan and Osterwalder (2017).

The above scenarios for potential applicable VT BMs are recommended based on the assumption that the actor that will provide the service of organizing the VT will be a 3PLS. This assumption has been made, considering that a company/actor that would provide only the service of organizing a VT would probably not be economically viable. This is the reason why, based on the authors’ knowledge and expertise, it is deemed more appropriate that the service of organising the VT will be one of the additional services that third party logistics service provides provide. If a ‘prioritisation’ was attempted among the above four BMs, BM2 and BM4 appear to be more applicable to the VT concept in the sense that a standard 3PLS, either regional or international, provides standard transport services and no additional services. Thus, considering that the organization of the VT is an additional transport service that a 3PLS can provide, a more ‘complex’ BM is required that will allow this specialized innovative VT service.

Taking lessons from the rail sector

In this section we examine potential BMs that could be applicable for the VT, in the case that the VTO is not a 3PLS but a company that owns at least the LV (dedicated or not) and maybe also some of the FVs. However, the existing general BM1 of a dedicated shipping company refers to forming a VT that is composed only by vessels that a shipping company owns. This the reason why the general initial BM1 is considered as applicable only for large shipping companies. However, an 'expansion' that could be made in the main elements of the BM1 is that under this BM the VT should not necessarily be composed of exclusively vessels that belong to one large shipping company. Indeed the VT can be either composed only of vessels which are property of the same shipping company (large shipping company in this case) or composed partially by vessels of the same company (being the shipping company that owns the LV and maybe one or more FVs additionally to that) and by vessels of other companies (small companies, e.g. owning one vessel). Therefore the target users of vessel owners that can use this BM is expanded. Under this BM1, it is not a third party that provides the service of organizing the VT but it is a shipping company that owns at least the LV and aims to gather also the FVs so as to form the VT. Therefore what is the difference of the BM1 with the BM2? The difference might be difficult[7] to understood between the scenarios that 1) a shipping company, which owns the LV (and maybe some additional FVs) but also adds vessels in the VT that do not belong to it, organizes the VT and 2) the third party service VTO. The difference is that in the BM1 the organizer is the shipping company and in the BM2 the third party service logistics provider and that the shipping company owns the LV while the third party service provider does not. In the BM2, all FVs need to pay a fee to the 3PLS for forming the VT and the LV as well, since the 3PLS does not own the LV and thus it provides a service also to the LV. In the BM1, a fee does not need to be paid by the FVs of the same dedicated company that organizes the VT, but it needs to be paid by the FVs that do not belong to this shipping company which provides the service of organizing the VT. Therefore the "external vessels", being the vessels that join the VT but not belong to the fleet of the shipping company that organizes the VT still need to pay a fee to the shipping company that will organize the VT. However, this BM (BM1) is found to be the BM that is furthest from reality based on interviews conducted by PLIMSOL. This is based on the belief that the VTO should be an independent company and not part of a shipping company. BM1 is deemed to be more easily applicable in reality if the VT is fully composed by vessels belonging to the same company (applicable for large shipping companies) but it is deemed to be more difficult to be applied in reality in the case the VT is composed by both vessels of the shipping company that organizes the VT and also by "external vessels". The difficulty derives from the 'sensitive' borderlines between competition and cooperation of different shipping companies.

Lessons will be taken from the rail sector for BM1 because similarities can be found. In the rail sector we have the locomotive which can be parallelized with what the LV is for the VT. Thus the rail transport operator that owns the locomotive of the train is like the shipping company that owns the LV of the VT. The rail transport operator is looking for wagons to join the train in the exchange of a fee, similarly the shipping company owning the LV is looking FVs to join the VT in the exchange of a fee. Sometimes all the wagons composing the train fully belong the rail transport operator or in

[7] The difference is clear when comparing the scenario when the shipping company forms the whole VT using its own fleet (being a dedicated shipping company) with the scenario of the third party service VTO.

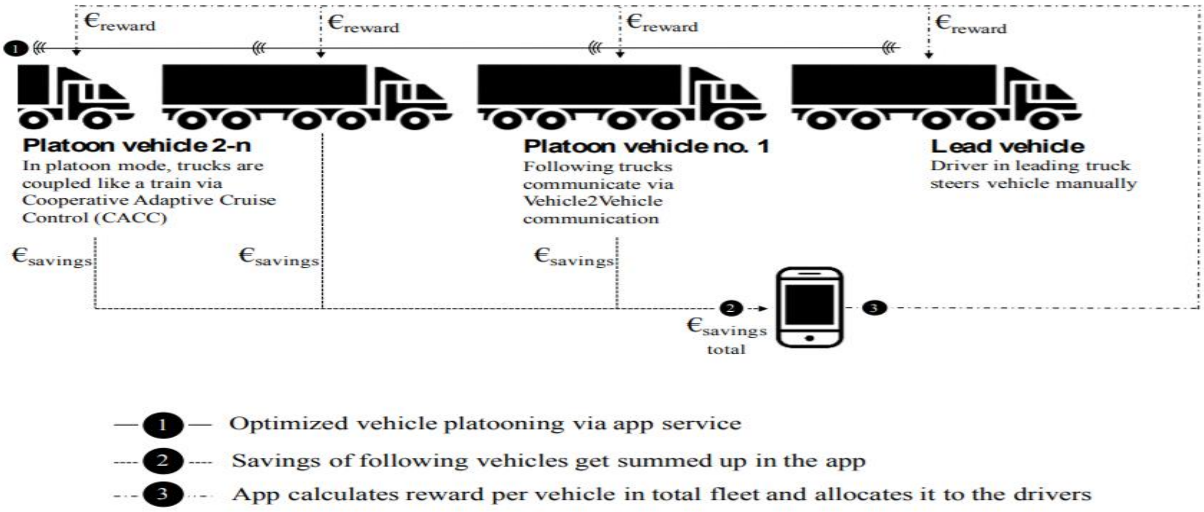
other cases wagons also belong to cargo owners (leasing the wagons for transporting their cargo). Thus there are similar BMs also for the rail sector for the transportation of cargo. The latest needs of the rail sector led to the improvement or in other words upgrade of the existing BMs in the rail sector for the cargo transportation. Bundling cargo comes as an innovative element in the BMs of the rail sector with either other rail transport businesses or by coordinating with their partners. Thus railway companies aim to optimize the use of transportation capacities and avoid low or mediocre percentages of loading space utilization of loaded rail cars (Petry et al., 2018, presentation). This BM was also considered to be used also for the VT concept (see van Hassel et al., 2018, D2.2.).

Another innovation that the rail BMs need so as to improve the reliability, speed and flexibility of the transport sector is to use digital technologies. Particularly, the digital BMs presented by Petry et al. (2018),are the following three: 1) process oriented, 2) analytics-based and 3) platform-based. The first digital BM *"aims at optimizing the process through the introduction of digital automation and processing technologies".* The VT in its core is a project that is characterized by digital technologies, since it is a project that introduces the use of partially autonomous vessels. A new (non-existing) IT software will be developed that will be installed in the LVs that will allow the control of the full train (all the FVs) by the LV. Thus, this allows also the reduction of the crew members on board in the FVs, since the navigational tasks are taken over by the LV and in the FVs there is crew on board that will be in charge for e.g. the engine of the FV in case there is a 'problem' and for probably helping with the mooring/unmooring, loading/unloading. The exact tasks or in other words the role of the only one crew member on board of the FV in the VT still needs to be fully specified. How does this digital technology contribute to a stronger BM and thus the generation of revenues (or also the cost savings)? Through the crew cost savings. The second digital "analytics-based" BM *"is based on the potential of advanced computer analytics such as big data and artificial intelligence".* The use of big data is also envisaged in the VT project for the development of navigation aid system (task 3.3 of the Novimar project). Particularly, the aim is to *"develop and test a navigation aid system that provides both live and forecast river depth and operational information for optimal routing, such as recommended speed and track, to VT's operating on inland waters" (NOVIMAR, 2017).* By collecting data The LV will need real time data on river condition (water depth, current, river bed) to navigate efficiently. At the present time ship masters take this information from visual observation, own measurement's and River Information Services (RIS), which could result into incomplete and incorrect information. Therefore by developing a navigation aid system that will provide "better knowledge on the interaction between vessel – river and correspondingly adapting speed etc., an energy saving potential of up to 10% can be achieved. This knowledge will help to optimise cargo capacities and reduce the risks of grounding and collision with bridges." *(NOVIMAR, 2017).*The third digital BM, being the 'platform based' refers to the use of digital technologies so as to reduce the transaction costs among all participants of the value chain. This is the only out of the three digital BMs of Petry et al. (2018, presentation) that has not been considered till now to be applied into the VT concept. This is a very interesting BM element because it would allow matching customers (in the VT case, cargo owners and/or vessel owners) with transport service providers (in the VT case, VTO either as a third party service provider or as a part of a shipping company). This is very useful for the VTO who will be in charge of searching for vessels owners that would like to join the VT and also for cargo owners that would like to transport the cargo via the VT; since the VTO is the intermediate person that bridges the cargo owners and the vessel owners. Therefore, a platform based BM would allow the reduction of search and matching costs that will be the main operational cost of the VTO. On the one hand, this will save costs from the project (reduction of costs for the VTO) and as a result on the other hand it may also contribute to the generation of more revenues indirectly. How could this happen? If the VTO costs are reduced, this means that the fee that would be normally charged to the users of the VT (being the vessel owners) will be also reduced. This will make the VT concept more attractive to the vessel owners because not only they will save operating costs thanks to the reduced crew cost but they will also need to pay a smaller fee so as to be able to join the VT. Thus we could summarize that the innovative BMs in the rail cargo sector are: 1) Bundling cargo for capacity optimization (of the rail cars) and 2) Digital BMs that focus on the use of digital technologies so as to increase reliability, flexibility and speed (of rail transport). Last but not least, we should also keep in mind that rail sector has similarities but also differences compared to the IWT sector and in general the waterborne transport sector. A main difference that also needs to be taken into consideration for the BM is for the rail sector there is an infrastructure track price that the users should pay and also dependency on the availability of the infrastructure. However, this is not the case for the waterborne transport modes. Also there is no need to plan railway paths one year in advance. There are no capacity problems are the inland waterway network.

Taking lessons from the road sector: truck platooning

Truck platooning is examined for extracting possible lessons learned with respect to its BMs because the VT concept resembles to a high extent the track platooning concept; both of them are platooning concepts (Hoyer et al., 2017, D.2.1). The VT platooning concept is inspired by the truck platooning concept and their main similar element is that the main advantage of both concepts is the labor cost reduction. However, there are additional prominent advantages of the truck platooning concept which are not valid for the VT platooning concept: 1) fuel savings and as a result reduced emissions, based on model tests performed, 2) the reduction of needed space thanks to the reduction of the inter-vehicle distance will be not of significant added value because waterborne transportation does not suffer from a lack of available space and 3) the safety aspect still needs to be proved (WP5) but we assume that the concept is safe, otherwise its realization will not be approved. Krüger and Teuteber (2018) conducted a study to identify BMs for truck platooning, which are user-centered with a focus on the Information System (IS). Based on literature, authors came up with two clusters of platooning: 1) the intra-fleet and 2) the inter-fleet. These two clusters are very similar to the initial BMs developed by the Novimar partners, being the BM1 of the dedicated shipping company (interpreted as intra-fleet, organized by the fleet of the company itself) and secondly being the BM2 of the third party shipping company (interpreted as inter-fleet by Krüger and Teuteber (2018)). For finding the BM of the intra-fleet platooning, the authors used a mathematical expression in which they calculated the difference between the cost functions with and without platooning. This difference shows the saving potential of platooning within a fleet. This mathematical expression looks like the indicators 1 and 2 as presented in D2.1 of Novimar (Hoyer et al., 2017) which calculate the cost advantage (for the VOs and the VTOs) by subtracting the costs when sailing with the VT from the costs when sailing without the VT. The results of Krüger and Teuteber (2018) showed intra-fleet platooning is a cost-saving business opportunity but not a new business model, since it is understood as an amortization issue (considering the platooning technology costs and labour costs). With the respect to the inter-fleet platooning, the following figures shows its developed BM.

Figure 1: Scheme of a platooning app business model, matching trucks in a platoon virtually to share the diesel savings belong all participants in the platoon



Source: Krüger and Teuteber (2018)

Figure 1 describes the BM, in which the authors envisage one central app provider that will be the matchmaker between potential platooning partners, taking into consideration route parameters, geo-positions and weight/speed indicators that will allow a precise computation of fuel savings per individual vehicle. This step is like the step 2 of the Uber BM as present in the next section. We see that this BM is also digital, like the rail BM. When the app calculates a positive platooning matching chance, both trucks have to accept. However, a truck can also decline the platooning offer (similarly with the Uber BM, see below). If the matching is accepted, the app extracts the savings of all the following trucks from the trucks' telematics system. So as to motivate financially truckers to join, the truck-individual savings are calculated and transferred to the app's back end, where all the savings of the platoon are captured. Then the rewards are calculated, taking the weighted % of savings generated by a truck compared to the entire platoon. The lead vehicle which will not generate revenues needs to also participate in the total savings so as to motivate potential leading trucks to start a platoon. This participation of the lead truck in the cost savings resembles the fee that the FVs should pay to the LV / VTO for forming the platoon. A simulation was also conducted for an inter-fleet platooning app. So as to sum up, it was concluded that inter-fleet platooning requires motivational incentives for the fleets and drivers, matching algorithms and easy and fast payment solutions.

Taking lessons from the airlines

According to Reichmuth et al. (2008) the airline BMs are the following: 1) Full Service Network Carriers (FSNC), 2) Low Cost Carriers (LCC), 3) Holiday Carriers, 4) Regional Carriers, **5) Traditional Freight Carriers, 6) Integrators,** 7) Hybrid Carriers. Two out of the seven BMs are related to freight transportation, while all the others to passengers' transportation. Nevertheless, lessons can be also taken from the latter BMs. For example, the FSNC is an airline that provides a broad range of pre-flight and on board services and the majority of these airlines operate using the hub-and-spoke system. The adoption of this system is interesting for the VT to be considered. Based on the hub-and-spoke system, cargo is transhipped in the hub port from big ships to smaller ships (feeders) which sail to the final destinations which e.g. are smaller terminals, with not very good access. This system could be combined with the concept of 'bundling cargo' presented by van Hassel et al. (2018, D2.2). Thus the VT could adopt the hub-and-spoke system and add an extra step of the cargo bundling, so as the VT not to stop to many different spokes but each VT to collect all cargo that is planned to go to the X spoke and bundle it in one VT, thus the VT will only do one stop to this specific spoke. Another lesson that could be learned from this BM is that it offers a broad range of pre-flight (and on board services). What if the VT considers not only providing the service of transportation to its customers (being the cargo owners) but also some additional services, such as the service of 3PLS providers/freight forwarders or/and cargo bundling. This is will facilitate the whole procedure that cargo owners should follow so as to transport their cargo to the desired destination. Including additional services prior the actual cargo transportation might also contribute to vertical integration for the shipping companies. For example, a current practice of the shipping companies is that they lease terminals and thus they manage mostly container terminals.

The two airline BMs related to air cargo transportation, being the Traditional Freight Carriers and Integrators see applicable for the VT concept, however the latter might create more competitive advantage for the VT service compared to the former. The traditional cargo carriers cooperate closely with forwarders who buy capacity of cargo from the airlines and also organise ground services, such as pick-up and delivery services. On the other hand, 'Integrators' offer also ground services (door-to-door services) thus controlling all the transportation process. Integrators also operate hub-and-spoke networks like the FSNCs mentioned above. This 'integrators' BM would be better applied under the existing initial VT BM2 which uses a third party as a VTO. Thus, in this case if the VTO is a 3PLS then not only the service of organising the VT could be included but also additional logistics services (see also the BM2 OF THIRD PARTY SERVICE as a VT organizer (VTO)).

However, we should keep in mind that a mix of BMs could be applied for the VT and not strictly a specific BM, thus being a 'hybrid carrier', such as Air Berlin in Germany that uses a BM that is composed of elements of FSNCs, LCCs and chart carriers.

Taking lessons from the Uber (platform systems)

The last general BM is the one providing a tramp/Uber service, which will be a demand-driven BM. Based on this BM, a FV could check the available LVs online via a cloud computing provider server. Therefore, the FVs do not need to wait for the LV. This is important because Novimar findings showed that the VT concept does not 'work' If the FV needs to wait for the LV or the VT to come. This would also reduce the crew costs of the LV because the crew of the LV would be called when there is demand for a VT service to be provided and thus there would be no need to pay the crew that is 'stand by' waiting. This BM is the one that was found based on expert's knowledge (based on two workshops organized by PLIMS in September 2018) to be the one that is closest to reality compared to the other two BMs which provide liner services and thus require regular and mass cargo so as them to work. The Uber BM would be good to be used during the initial phase of the VT project, being the first 2-3 years of the project's operation, which are crucial for defining projects' economic viability. It is the time period during which the project is introduced and still the users get to know it. This is the reason why, often projects receive subsidies during the first 2-3 years of their life. Last but not least, it is evident that also this BM is digital, since it makes use of a cloud-based system.

In this section we examine if Uber's BM could be applicable for the VT concept. In the case the Uber BM is used for the VT, the cash collected by each trip will be the only revenue for the vessel owners, as it would also be in the case of a conventional vessel sailing independently (outside a VT). Therefore the source of the revenues is the same in the 'with-VT scenario' and in the 'without-VT scenario. VT, like the Uber will not limit itself to a particular types of vessels. The vessels will be of different sizes and for different markets (SSS, sea-river and IWT). Therefore cargo owners can select among a wide range of vessel types and sizes. Surge pricing is applied, which means that price will increase based on the supply and demand of the market, calculated based on an automated algorithm. Therefore here we can also see that this BM is also digital, as for the rail sector. However, if surge pricing is applied in the VT, it is recommended that a price cap should be applied to avoid 'losing' potential customers (cargo owners) due to the very high price. Some main features of the VT Uber BM are: a user (cargo owner) can go online and ask for a vessel to transport the cargo. The vessel owner (VO) has the option to reject or accept the trip. If the VO accepts the trip, the details of the VO will be sent to the customer (cargo owner) with the estimated time of possible departure of the vessel. The payment procedure is handed by them. The BM will have a rating system for the VOs/ captains, where the cargo owner/customer can rate the VO after the completion of the cargo shipment to the requested destination. Therefore the 'reliability' of each vessel operator will be shown in this rating system, thus also motivating the vessel operators to achieve certain guaranteed lead times so as to attract the cargo owners, since competition will be high among the vessel operators. With respect to the value propositions for the customers/cargo owners: FV (loaded with cargo from the cargo owners/customers) does not need to wait long times for the LV/VT; discounts might be offered sometimes, depending on the number of the FVs joining the VT, which would lead to a lower VT fee (the fee that the VOs need to pay to the VTO and the LV). Prices are expected to be less than the ones of the conventional vessel fees due to the reduced operational costs (less crew on board). With respect to the value propositions for the VOs/vessel operators: additional source of income, flexible working/operating schedules of the vessel, a payment could be also given to the VOs to be online, even if they do not get any request (like Uber does). With respect to the customer segments: the concept refers to cargo owners that do not own a vessel and they would like to transport their cargo via a vessel and to cargo owners that want a cost-efficient transport for their cargo. How to find customers for the Uber VT service? This could be achieved through a marketing team that will contact VOs/operators. Online advertising or newspapers could also be a way to communicate the innovative Uber VT service to the potential customers. Based on the 4-step model of how Uber works, the 4-step model of the Uber VT is also structured: 1) requesting a vessel trough an online system; 2) matching between the cargo owner and the VO; this means that as a cargo owner you can see if the VO accepts the request of the cargo owner, 3) vessel trip; the cargo owner might is also informed about the estimated time of departure of the vessel and of arrival, which is crucial for enhancing the reliability of the service (guaranteed lead times). The 'meter' will start as soon as the loading of the cargo starts, 4) payment and rating: as soon as the cargo is transported to the requested destination, the cargo owner can rate the service of the vessel operator. Rating system is important part of the BM because it informs the cargo owner about the reliability 'scores' of the different VOs. Some key lessons to take from Uber BM are the following: 1) use a less ownership model, meaning that owning vessels is not necessary; 2) pay lots of attention on providing reliable cargo deliveries with guaranteed maintained lead times, 3) treat the captains/VOs as partners and give to them a decent percent of the total fare (80% in the Uber case). (Source: Jungleworks (7 March 2019, Date of access))

5.2.2.2 Initial BM development (step 2)

Based on the lessons learnt the initial versions of the BM are developed. The approach used is that 4 different initial business models are developed via a business model canvas which focuses on the value proposition of the BM. This canvas can be seen in table 2.

Table 2: Initial business model development

Case Study X		
Business model	(uber, tramp, liner)	
Role of LV	(dedicated service LV, multi-use cargo LV, dedicated cargo LV)	
Stakeholders	1	
	2	
	3	
Role of Stakeholder	1	
	2	
	3	
	…	
Responsibilities of Stakeholder	1	
	2	
	3	
	…	

Frequency of Departure		
Operating Sector/ Area		
Operational Issues	communications	
	extra operational tasks required	
Positive aspects of this Case Study for the Assessment of the VT		
Limitations of this case Study for the Assessment of the VT		
Value Proposition		
1		
2		
3		
Charging scheme between the VTO & the FV		

The initial developed business models are:

- Liner shipping, with a dedicated lead vessel
- Tramp shipping business model, with cargo transporting lead vessel
- Liner (one shipping company owning all the fleet)
- Digital platform business model

In appendix B the initial business model are shown.

5.2.2.3 Results from the stakeholder interviews

The developed initial business model are presented to 13 actors. The questions that were asked to the interviewees are the following:

- Which of the four BMs seems the most applicable to reality, based on your knowledge & expertise?
- Could you rank the four BMs from the closest to reality (best score: 1) to the furthest from reality (worst score:4) [scores: 1-4].
- Do all the four BMs seem equally applicable to you for both IWT (inland waterway transport), SSS (short sea shipping) & sea-river transportation? (if not, could you allocate each of the BMs to the waterborne mode (IWT, SSS, sea-river) that is better applicable?
- Based on your expertise, a) would you add an element to strengthen the proposed BMs; or/and b) would you delete an element to strengthen the proposed BMs?
- Would you allocate a BM to a specific commodity/market (bulk, intermodal) or region (e.g. Lower Rhine, Upper Rhine, German Canals, North Sea, Baltic Sea)?

The main results of these interviews are given in appendix C. Table 3 summarizes the overall key main findings of all the four BMs per interviewee.

Table 3: Overview of the main findings of the interviews.

Interviewee	Mode	Best BM	Worst BM	Applicability to IWT/SSS/ sea-river	Elements to add or omit	Cargo type per BM	Region	Key comments
Freight Forwarder	Rail Road IWT	BM4	BM3	-	-	BM4: general and bulk cargo on the Danube. BM3: Liner/one shipping company is the owner of all fleet is not applicable on the river Danube. Nowadays, there are also dominant shipping companies that do not allow other companies to fleshy pot.		Why BM4 is the best? Independent organizer could control the business, Might be profit sharing in the pool, Much less capital investment is needed.
Broker (& vessel owner)	IWT	BM4	BM3	-	- Think not only of the composition of the VT in terms of types & sizes but also in terms of the order in	-		- You start from the platform and from having individual barge owners not one owner for all barges in the VT. - BM4 is the best, speaking from the perspective of the

					which the vessels will be positioned in the VT. Which will be the 1st , 2nd …last.		COs, because all the information is centralized (e.g. through the algorithm) & opti-mized; e.g. I will know what time the barges will be ready to be decoupled, depart etc. and also the algorithm will decide about the positioning of the barge in the VT (meaning which barge will go last). - BM3 is the worst because this belongs to the past. - BM1 and BM2 would be good but with the platform (as shown in BM4). - Resemblance of the VT concept with the pusher & puller barges concepts. - Linking the LV with the puller. General remarks about VT: - Lock passage: due to the various sizes of vessels in the VT some vessels might not be able to pass from the lock. - It is not positive if LV has to wait for all the other FVs to (dis)charge. - It is not positive if there is waiting time to depart considering the investment costs that the barge

								should do. - Frequency needs to be high, not to have long waiting times.
Vessel owner	IWT	BM3	BM1	All of them could be applied for IWT, SSS & sea-river.	-	Transporting containers will be complicated. Other types of cargo would be more suitable, i.e. 1) liquid cargo (e.g. oil), 2) building materials (e.g. sand), 3) agricultural products.	1a) Duisburg to Rotterdam and 1b) Duisburg to Antwerp and maybe also consider applying the VT in 2) the Albert Canal.	- Get CCNR involved since these procedures take long time. - Lack of crew in the IN sector. - The LV should only have one job, to lead the VT. - Tramp service seems better.
Logistic service provider & Vessel owner	SSS	BM1 & BM3 & later BM4	BM2	Start simple: with IWT barges	-	Start simple: with contain-ers/break bulk	-	- BM1 & BM3 are the best models to start with, since they are the simplest and each of them will be applied depending on the size of the shipping company. - BM4 is the best to be applied but gradually. - Start simple: with contain-ers/break bulk and with IWT barges. - Do not focus only on the per-spective of the VO but also on the

								CO. It is good to also involve them and to ''secure them'' to have long time charter contracts.
Vessel owner	IWT	BM3	BM4	All of them could be applied for IWT, SSS & sea-river.	Do not include multiple VOs/stake-holders. I am sceptical with cargo flows when having multiple stake-holders in one VT, it will be difficult to combine in one VT different COs & VOs; this might have an impact on lead time. Maybe it seems good the-oretically, but it will be easy in practice.	All cargo types could be transported but to start with contain-erized cargo.	-	- BM3 is the most applicable; being the owner of the whole VT, owning the whole fleet (for IWT). Otherwise there will be conflict of interests. - Start small, with 1, 2, 3 stake-holders. Start small and simple.
Vessel owner	IWT	BM3	BM4	For the BM1 and BM3, the best is IWT, then Sea-River. For the BM2, IWT, SSS and Sea-River are convenie nt. For the BM 4, the best is SSS, Sea-	a)We need to add for each BM the responsi-bility of the VT, and the insurance that will cover the cargo and the vessels; b)On Case 2, the fact that the LV has a cargo capacity is not a dif-ference of	The system of motor vessel is mostly adapted to regular transports, as shuttle, in this case BM1 and BM3 are better for the VT concept (type of market). In term of areas, the Main Channel has specific rules we must deal with. It is not possible to apply the concept to the Danube, the freight rates are too low, the crew's fees are low, and the convoys can be composed with 6 to 8 barges of 2000		-BM3 (Liner, full owner) would be the most applicable scheme to reality of IWT. The VTO is mastering all elements of the VT and can coordinate the logistic chain. He/She is only using FVO as a shipping agent to have access to the cargo demand. - BM1: The organization of the chain is clear, and efficient.

				River, then IWT.	BM, we could also have a cargo capacity for the LV in the other BM.	tons. Novimar is also supposed to study the area of the Seine, so we'll see how it can be managed.		- BM2: The advantage for the FVs to use the VTO is not big enough. The FVs could directly book their space with the COs without paying fees to VTO, and mostly to avoid a too long idle time. - BM4: There are lots of questions in this case; who is responsible of the VT, who will take the roles of the LVO/FVO in case you have the same technology on all the vessels? It seems to be a kind of stock exchange for IWT, the COs have no guarantees in the conditions of the transport (ETD, ETA, conditions of the cargo hold etc.). The COs will ask for a price per ton, which could be different according to the numbers of FVs able to make the transport.
Barge operator	IWT	BM3	BM4	-	-	-		BM3 is the best option as of the importance and the coordination of all vessels should be in the hands of the VT to be at it is most effective, also the LV should be cargo less.
Broker	IWT	BM3	BM1 BM2 BM4	All four BMs are more applicabl e for SSS;	-	BM3 is applicable for in-termodal transport (container	-	BM1: Dedicated LV seems to be the most unlikely. BM3: The VT seems technically and operationally

						)		feasible, if all processes are controlled by one operator. BM4: Users have not accepted this type of service due to their lack of trust and their unwillingness to share sensitive data.
Intermodal logistics ser-vice provider & barge operator	IWT rail road	BM3 BM4	BM2	IWT	The transparenc y of the entire process needs to be provided including clear liability of each of the stakeholder s involved.	Intermoda l (container), bulk	Rhine, Danube, Elbe, German canal network	BM3 is the best case to imple-ment the VT operations as the management and responsibility is focused in one company.
IWT operator, vessel owner and vessel sales & leasing	IWT	BM3	BM2	SSS	Fleet managemen t and vessel operations may be provided by different stakeholder s to minimize risks.	All cargo types could be transport ed but to start with intermoda l.	Waterway s with no or very big locks	BM3 is the best case to imple-ment the VT operations as the management and responsibility is focused in one company. Financial management of investment due to the low margin in IWT is key to any BM.
Waterway authority	IWT	BM3	BM2, BM4	IWT	The leading role of the LVO is crucial, the FVs are to benefit from the experience and ideal path provided by the LVO. Entry fee may be a show-	n/a	The Rhine, the North and West German waterway s and the Benelux waterway s (rather than Danube)	BM3 is the best model as a central governing body may seek synergies and dispatch the units optimally. The leading role of the LVO is crucial, the FVs are to benefit from the experience and ideal path provided by the LVO (which again

					stopper.			may not be explicitly linked to the VT concept).
Intermodal logistics service provider	Sea Air Rail Road Contract Logistics	BM4	BM3	IWT (only)	Staff pooling might be economically beneficial to strengthen the business models BM4 and BM1 even further.	n/a	Areas with lots of locks and bridges as well as areas with crossing traffic, like the one of ferries crossing the Rhine, may not be the best application areas	BM4 is the most promising BM as it relies on an efficient digital mechanism to match supply and demand. In addition, the transparency of the marketplace allows bigger and smaller entities to participate easily without too much coordination effort, neither on the side of the LVO nor on the one of the FVs. The entire VT concept appears to be of limited applicability in SSS because the lower frequency of services and the heterogeneity of origin-destination relations lead to smaller parts of joint voyage and, hence, does not permit the building and operation of vessel trains.
IWT interest group	IWT	BM4	BM1	IWT SSS	It is important to understand that the main benefit of joining a VT is the experience and ideal path provided by the LVO to the FVs. However,	Liquid bulk all types of cargo	The main application area for vessel platooning will be between Duisburg and Rotterdam or Antwerp, respectively.	BM4 is the most interesting BM because a marketplace helps matching supply and demand for LVOs ready to create a VT. BM1 would be a waste of valuable transport capacity because there is no need for a dedicated LVO

					this is not necessarily confined to VTs but can also be offered by dedicated navigation assistance systems, especially in times of artificial intelligence and machine learning.			and his LV. However, the general skepticism regarding VTs due to many operational doubts, e.g., regarding the uphill/downhill voyage and the maneuvering along turns, does not contradict the fundamental approval of the proposed business model of BM4. For instance, building a convoy, especially with tank vessels, is not only a question of coupling the vessels but requires also careful checks with existing capacities at ports and dispatch points. Mostly, the tank vessels will continue to be loaded sequentially, so that a convoy of x tank vessels with 8 hours each loading time would require more than two entire days to even set up the VT!

The results of the interviews are very interesting. 13 relevant transport stakeholders were interviewed from different European countries, being the Netherlands, Belgium, France, Hungary, Germany and Austria. The names of the companies and of the interviewees are not disclosed for confidentiality reasons. However, the role of each of them is indicated. The concept of the VT was parallelized with the concept of the tug boats in IN (interviewee no. 2 & 3), and thus it was considered as a modern version of it. But this was not the only similarity found among the answers of the interviewees.

The overall conclusion is that 8 out of the 13 interviewees, most of them being VOs voted BM3 as the best BM and 6 out of the 8 voted BM4 as the worst. This shows that VOs prefer the management of the whole VT to be made by one shipping company to avoid any trust issues and conflict of interests. On the other hand, the rest 5 of the interviewees, being intermodal logistics service providers, freight forwarder, broker and IWT interest group voted BM4 as the best BM, supporting that the advanced technologically platform will allow the best management of the VT and matching of demand and supply. 4 out of the 5 believe that BM3 is the worst or the 3rd worst BM. Thus, it is concluded that the main two prominent BMs, based on the votes of the interviewees, are the BM3 and BM4. Therefore, Novimar will apply these BMs for conducting the VT project evaluation.

Some key comments that need to be taken into consideration are the following: 1) we need to start simple, 2) to start with containers/bulk cargo (however the interviewees no. 3 and 13, who are a VO and IWT interest group respectively, do not agree with the applicability of transporting containers with the VT but they believe that liquid cargo is more promising), 3) to start with IW barges, 4) to start with a few only stakeholders, 4) to have high frequency of departures, 5) to focus not only on the VOs but on the COs and consider using 'long term charter contracts', 6) to add for each BM the responsibility of the VT, and the insurance that will cover the cargo and the vessels (both the interviewees no. 6 and 9 mentioned this point, being a VO and an intermodal logistics service provider and barge operator respectively, thus seeing that liability is of high importance for both stakeholders) and 7) LV should definitely be cargoless/dedicated (which was pointed out by two interviewees, no.3 and no.7, who are both VOs, although interviewee no.8 pointed out the opposite, that the LV should not be dedicated because then as the operator, it is economically totally dependent on demand from FVs. The LV cannot be used for other purposes. 8) Locks play an important role for the operation of the VT; due to the various sizes of vessels in the VT some vessels might not be able to pass from the lock (Interview 2: broker and barge owner) and thus no or big locks might be preferable (Interviewee 10: IWT operator, vessel owner and vessel sales & leasing (IWT) and Interviewee 12: Intermodal logistics service provider). 9) The entry fee for the VT may increase reluctance to adopt the service. 10) Staff pooling might substantially help the BMs to become even more attractive and economically viable. Table 4 summarizes the scoring of all the four BMs per interviewee.

Table 4: Scoring of the BMs (best score: 1, closest to reality) (worst score: 4, furthest from reality) [scores: 1-4]

	Interviewee	BM1	BM2	BM3	BM4
1	Freight Forwarder	2	3	4	1
2	Broker (& vessel owner)	2	2	4	1

3	Vessel owner	4	3	1[8]	2
4	Logistic service provider & Vessel owner	1	4	1[9] (2)	3[10]
5	Vessel owner	3	2	1	4
6	Vessel owner	2	3	1	4
7	Vessel owner	2	3	1	4
8	Broker	4	3	2	1
9	Intermodal logistics service provider (IWT, rail, road)	3	4	1	1
10	IWT operator, vessel owner and vessel sales & leasing	2	2	1	3
11	Waterway authority	2	4	1	3
12	Intermodal logistics service provider	2	3	4	1
13	IWT interest group	4	2	3	1

Based this overview it can be concluded that vessels owners opt for BM3 (liner option) while the other actors mostly opt for BM4. This implies that vessel owners opt for the BM in which they have full control of the VT. While the service providers opt for a more modern type of business model in which there is no direct control of a single large player, but a platform.

5.2.2.4 Selected business models

Based the results of the interviews, the two selected business models are:

- BM3: Liner (one shipping company owning all the fleet)
- BM4: Digital platform business model

The main points of the these two business models are given in tables 5 and 6.

[8] BM3 to start with so as gradually to apply BM4.

[9] BM3 to start with so as gradually to apply BM4.

[10] BM4 is the best but to be applied gradually.

Table 5: Main outline of BM 3 (liner model)

Business model		Liner (one shipping company owning all the fleet)
Role of LV		Dedicated LV
Stakeholders	1a	VTO and LVO
	1b	FVO
	2	CO
Role of Stakeholder	1a	VTO owns the LV & the FVs (all the fleet). VTO is a shipping company that owns all the fleet. VTO manages the FVs. VTO owns the technology to coordinate the VT & also the technology that the FVs require so as to be able to follow. VTO is the same actor with VO in this case study. VTO does matching between VT & COs[1]. VTO does not charge the FVs for the service provided in this case study because these costs are considered internal costs since all the vessels belong to the same shipping company. VTO/shipping company contacts the COs. VTOs/shipping company need to own the dedicated LV. (They can own or charter the FVs).
	1b	FVs transport cargo from A to B and have the technology to be able to follow. FVOs receive booking of cargo and allocate cargo into FVs.
	2	COs book cargo in the FVs via the VTO.
Responsibilities of Stakeholder	1a	To build & organise the VT & keep the VT safe (management of the VT). Ensuring the departure & arrival times. (communication responsibilities).
	1b	To be ready to depart (arrive) and be ready to leave the VT. To manage cargo according to demand of CO.
	2	COs provide service requirements to VOs on time. Pay bill to LVO/FVO (shipping company).
Frequency of Departure	High	
Operating Sector/ Area	Medium to long distance (multiple stops) Applicable for both SSS, IWT & Sea-river.	
Value Proposition		
1a	VTO does not earn money as an independent actor as such by the FVOs, by providing the VT organisation, since the VTO is the shipping company that also owns the FVs (all the fleet). However, the VTO earns money (from the COs) for his/her shipping company for organising and operating the VT.	

1b	VOs: Lower operational costs. VOs: Increase of operational time. (esp. for small ships)
2	CO: Lower transportation cost. CO: Less waiting time due to higher frequency of transport service. CO: Lower capital tie-up of cargo due to shorter transport duration (lower in-transit inventory cost and lower safety cost for the CO because lead time is shorter).
Charging scheme between the VTO & the FV	Everything belongs to/is operated by the same shipping company, thus there is no explicit markup. Thus, the costs that would be normally paid by the FVs to the VTO (if they would not belong in the same shipping company) are now considered as part of the operational costs. (internal costs allocation)

Table 6: Main outline of BM 4 (Digital platform business model)

Business model		On demand platform
Role of LV		Cargo LV
Stakeholders	1	VTO
	2	LVO, FVO
	3	CO
Role of Stakeholder	1	VTO is a virtual service (app is also used). VTO has the legal responsibility of payments. VTO does not own any vessel, thus less capital is needed.
	2	VO transports cargo from A to B & has the technology to be able to lead (LV) and to follow (FVs). FVOs need to subscribe to the platform & be on time (same for the LVOs). LV can decline a FV.
	3	COs book cargo in the FVs via the app.
Responsibilities of Stakeholder	1	VTO is a virtual service. VTO builds & organises the VT. VTO provides the management of the VT:

		* keeping the VT safe * ensuring the departure & arrival times * communication responsibilities to FVs and the "outside" operational environment (external parties). VTO sends out bill to FVOs.
	2	VO should be ready to depart (arrive) and be ready to leave the VT & pay the submission fee to the platform. LVO/FVO manages cargo according to demand of CO.
	3	CO provides service requirements to VO on time. CO should pay the bill to the LVO/FVO & also should pay the submission fee to the platform.
Frequency of Departure	Demand based	
Operating Sector/ Area	High density network with a lot of movements. Applicable for both SSS, IWT & Sea-river.	

Value Proposition	
1	VTO is a virtual service, which might be cheaper because it is provided by a platform and thus it does not require labour.
2	VOs: Lower operational costs. VOs: Increase of operational time (esp. for small ships). VOs: Cheaper VTO service for FVOs.
3	COs: Lower transportation cost. COs: Less waiting time. COs: Cheaper VTO service for the COs.
Charging scheme between the VTO & the FVO	Payments through the virtual service of the VTO based on a "lump-sum" base.

5.2.3 Results sub-task 2.3.2 (VT operational issues)

This sub tasks is structured as follows: First the operational issues and the lessons learnt from the rail freight sector are given. Next to that it can be concluded that the operational issues of the VT are very much dependent on the type of selected business model. From the analysis of the previous section (task 2.3.3) two main business models are selected and validated. These selected and validated business models will determine also what the main operational issues are for the VT. Per business model these operational issues will be mentioned.

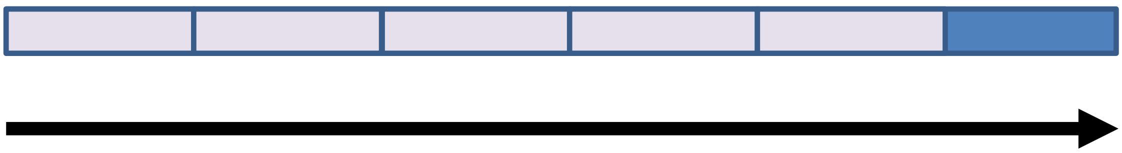
5.2.3.1 Operational issues, lessons learnt from the rail freight sector

Rail operation principals

Rail freight operates with trains, which is a composition of freight wagons and the locomotive. The freight wagon is unmanned, unpowered and transports the cargo from origin to destination, which might be a rail siding or a rail terminal. The powered and manned locomotive is dedicated to pull a set of wagons only, which means it does not carry freight itself. There are in principal 3 methods to operate the rail freight train:

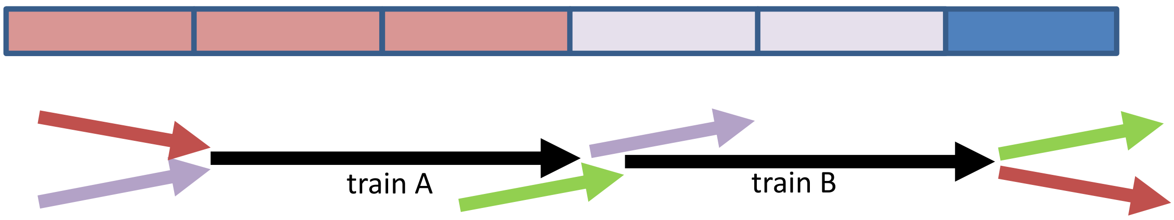
block train

A block train is a train composition of rail freight wagons which runs entirely from origin to destination. If the locomotive joins the composition throughout the entire trip or only on a section depends on the type of locomotive, the variety of infrastructure along the trip and the operational planning of the locomotive fleet.



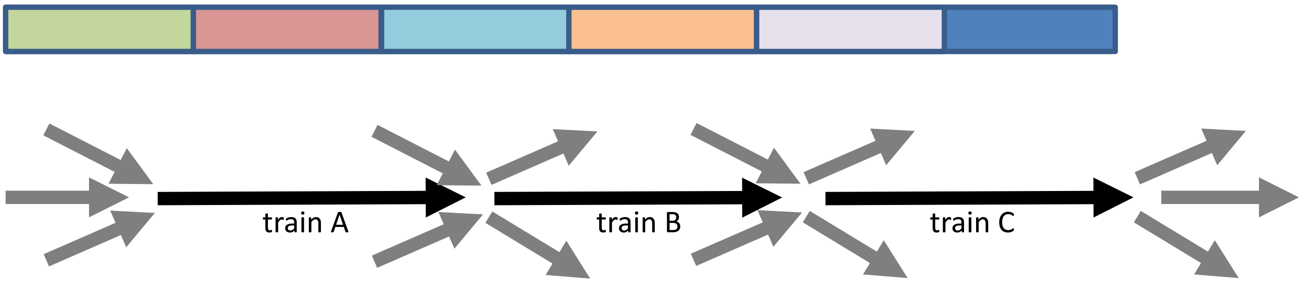
feeder or multiple-section train

A feeder or multiple-section train consists of a composition of 2 or more fixed groups of wagons with different origins and destinations. A group of wagons may switch from one train to another train. It may also be coupled to or uncoupled from the train along the trip of the train.



single wagons

Single wagons operate from their origin to their destination joining varying train compositions while switching between them at hubs (shunting yards). The long-distance locomotive is in most cases being uncoupled from the wagons before shunting takes place. To perform an efficient shunting operation a specific infrastructure (hump for gravity shunting) is required.



Adaptation of rail to vessel train operations

block vessel train

Block vessel train operations is applied todays in push barge operations. Nevertheless, a vessel train which does not change its composition from origin to destination is not exactly within the scope of a vessel train. Push barges would serve the purpose much cheaper as they do not require propulsion. The purpose of a vessel train, as it is also defined for this project NOVIMAR, should allow flexible operations of various follower vessels between various ports of origin and destination. This type of operation, the block vessel train, is therefore not to be considered for a vessel train.

Feeder or multiple-section vessel train

A group of follower vessels could run from a big (sea) port with different origin terminals to a destination, may it be a big (inland) port or a metropolitan area, with has multiple terminals in a relatively small area. A multiple-section vessel train can be formed if each group of follower vessels serve a different port by travel together on the main run in a vessel train. An example would be if one group of vessels starts in Antwerp while another group of vessels from Rotterdam is being picked up further along the voyage to the destination along the Rhine.

Another option for multiple-section vessels would be to switch a group of follower vessels between two different lead vessel liner services at a hub. This option is applicable mainly if there is sufficient demand from one point of origin at one liner service to another point of destination at another liner service. An example would be if one liner service runs on the Rhine up to Mannheim and another further upstream to Basel. A typical link would be between the seaport of Antwerp or Rotterdam and the inland ports in the Basel region.

Individual follower vessels in a vessel train

While single wagon can join or leave a rail train only in railway stations, follower vessel can join or leave a vessel train at almost any point along its voyage. If a vessel train serves a hub, the movement of follower vessels to their destination within the hub (terminals) or to their meeting point with the next vessel train has to be managed.

5.2.3.2 Operational issues BM 4: On demand platform

The main operational issues of the on demand platform business model are given in table 7. In this business model different vessel operators can join the VT. This means that the VTO needs to put a lot of effort to organize the VT.

Table 7: Operational elements of the on demand platform business model

Stakeholders	1	VTO
	2	LVO, FVO
	3	CO
Role of Stakeholder	1	VTO is a virtual service (app is also used). VTO has the legal responsibility of payments. VTO does not own any vessel, thus less capital is needed.
	2	VO transports cargo from A to B & has the technology to be able to lead (LV) and to follow (FVs). FVOs need to subscribe to the platform & be on time (same for the LVOs). LV can decline a FV.
	3	COs book cargo in the FVs via the app.
Responsibilities of Stakeholder	1	VTO is a virtual service. VTO builds & organises the VT. VTO provides the management of the VT: * keeping the VT safe * ensuring the departure & arrival times * communication responsibilities to FVs and the "outside" operational environment (external parties). VTO sends out bill to FVOs.
	2	VO should be ready to depart (arrive) and be ready to leave the VT & pay the submission fee to the platform. LVO/FVO manages cargo according to demand of CO.
	3	CO provides service requirements to VO on time. CO should pay the bill to the LVO/FVO & also should pay the submission fee to the platform.
Frequency of Departure	Demand based	
Operating Sector/ Area	High density network with a lot of movements. Applicable for both SSS, IWT & Sea-river.	
Operational Issues	communications	FVO & LVO communication: * organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT). * navigational, e.g. communication with respect to the distance and speed with which the FVs should sail. LVO communicating to operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).
	extra	Lock passage.

	operational tasks required	VTO/virtual service does matching between LVs & FVs & them with the COs. Careful Purchasing decision for the FVs.
Charging scheme between the VTO & the FVO	Payments through the virtual service of the VTO based on a "lump-sum" base.	

5.2.3.3 Operational issues BM 3: Liner (one shipping company owning all the fleet)

The main operational issues of the liner business model are given in table 8. In this business model a large shipping company is operating the VT. Therefore the main shipping has the full control on the organization of the VT.

Table 8: Operational elements of the liner business model

Stakeholders	1a	VTO and LVO
	1b	FVO
	2	CO
Role of Stakeholder	1a	VTO owns the LV & the FVs (all the fleet). VTO is a shipping company that owns all the fleet. VTO manages the FVs. VTO owns the technology to coordinate the VT & also the technology that the FVs require so as to be able to follow. VTO is the same actor with VO in this case study. VTO does matching between VT & COs. VTO does not charge the FVs for the service provided in this case study because these costs are considered internal costs since all the vessels belong to the same shipping company. VTO/shipping company contacts the COs. VTOs/shipping company need to own the dedicated LV. (They can own or charter the FVs).
	1b	FVs transport cargo from A to B and have the technology to be able to follow. FVOs receive booking of cargo and allocate cargo into FVs.

	2	COs book cargo in the FVs via the VTO.
Responsibilities of Stakeholder	1a	To build & organise the VT & keep the VT safe (management of the VT). Ensuring the departure & arrival times. (communication responsibilities).
	1b	To be ready to depart (arrive) and be ready to leave the VT. To manage cargo according to demand of CO.
	2	COs provide service requirements to VOs on time. Pay bill to LVO/FVO (shipping company).
Frequency of Departure	High	
Operating Sector/ Area	Medium to long distance (multiple stops) Applicable for both SSS, IWT & Sea-river.	
Operational Issues	communications	FVO & LVO communication: * organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT). * navigational, e.g. communication with respect to the distance and speed with which the FVs should sail. LVO communicating to operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).
	extra operational tasks required	Lock passage VTO does the matching with the COs (and the FVs which belong to the same shipping company).
Charging scheme between the VTO & the FV		Everything belongs to/is operated by the same shipping company, thus there is no explicit mark-up. Thus, the costs that would be normally paid by the FVs to the VTO (if they would not belong in the same shipping company) are now considered as part of the operational costs. (internal costs allocation)

5.2.3.4 Assessment of Mooring Operations of FV in the port

Following vessels, leaving the vessel train (VT) and sailing to a terminal, may need assistance at inland terminals for mooring the vessel. Such assistants will come at a cost, which needs to be taken into account in the VT business model and market diffusion plans.

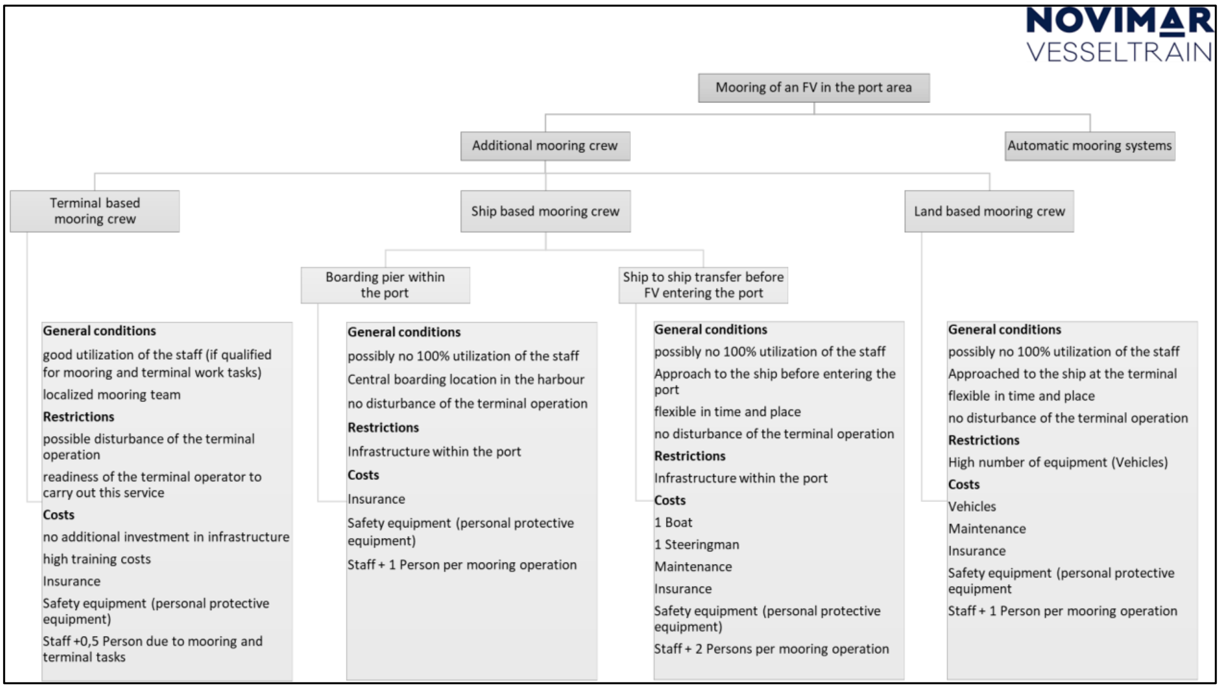
Currently, vessels entering the terminals require at least two crew members for vessels smaller than 86 meters and three for vessels larger than 86 meters, respectively. In the case of the crew level on a FV being smaller than the required official numbers, external assistants may be required.

There are several different ways to assist vessels at inland terminals, i.e., with the help of

- automated systems,
- Additional mooring crew:
    - inland terminal personnel (e.g., crane drivers) delegated to mooring
    - a ship-based mooring crew (not including the crew onboard of the FV).
    - Ship based mooring crew
        - Boarding pier
        - Ship to ship transfer

In figure 2 the overview of the mooring options in a port for a FV can be seen.

Figure 2: Overview of Mooring Operations of FV in the Port



In the present research, the focus will be laid on additional crews at inland terminals, not on automated systems. Deploying operational terminal personnel would be synonymous with interrupting their other main duties. The reason for this lies in the aim of the NOVIMAR project to minimize the amount of investments in infrastructure and vessels. If automated mooring systems were opted, large capital investments would be required while their frequent usage is not ensured notably in smaller inland terminals which again contradicted the original idea.

Figure 2 shows an overview of different variants of mooring operations of an FV in the port are, encompassing both automatic mooring systems and additional manpower. The latter can be broken down into concepts based on a terminal-based, land-based, and ship-based mooring crew. Within the concepts based on a ship-based mooring crew, two further variants can be differentiated, namely the use of a boarding pier with in the port and the ship-to-ship transfer prior to the entry of the FV into the port. Each of the concepts is presented hereafter.

Automatic Mooring Systems

Fully automatic mooring systems provide an alternative to traditional mooring. In connection with the VT, these systems should not be considered for the time being. The systems are not yet available in inland waterway transportation, especially for freight shipping. Moreover, investment in such systems is expected to be high.

Some available technologies, such as jack-up systems, are banned in many ports and will therefore not be considered further.

Semi-automatic systems such as winches are already in use on various types of ships. However, they cannot replace personnel-based mooring.

Additional Mooring Crew

The nearer option is to use additional mooring crew in order to facilitate VT operation and FV entering ports. The underlying assumption is that one vessel in a VT aspires to leave the VT and enter the port at a time. The different variants of assisting the mooring operation are presented in the following.

Terminal-based mooring crew

The terminal-based mooring crew is made up of terminal employees who must be additionally qualified in order to complete the new mooring-related tasks. As a result, each embarkation terminal needs its own qualified personnel for mooring operations.

If the terminal-based mooring crew is assisting in mooring operations, the residual terminal operations may be interrupted or disrupted at short notice. Close consultation between the operator of the terminal and VT or FV can reduce such interruptions. Early registration of the FV is important here for terminal operation planning. Also, ETA needs to be provided by the vessel to the terminal operator to enable efficient working of the terminal-based crew without waiting time. The times to be planned for the process have to be lavish since the distances to be covered by the employees must be taken into account adequately. These travel times can be considerable, especially for personnel working on quay cranes.

The additional qualification and the resulting higher salary costs for the terminal personnel will result in higher costs for the terminal operator. The costs for personal security equipment can be kept low as a high standard of security at port terminals is already lived at port terminals.

Due to the existing personnel and their advanced training, only a small increase in headcount (e.g., plus 0.5 FTE) will probably be necessary. However, this figure can vary greatly depending on the organisation of the terminal. In addition, the terminal operator must be principally willing to offer this mooring service for shipping and VT. The services will probably be invoiced directly to the mooring vessels.

Ship-based mooring crew

The ship-based mooring crew is a team working independently of the respective ship. This team consists of one or two persons and is ordered before the VT reaches the port or terminal. There are two different options for boarding the mooring team to the FV, i.e., via a boarding pier within the port or via ship-to-ship transfer before the FV entering the port. Both variants shown are suitable for safe boarding. However, they differ in their flexibility and the resulting costs. The costs for personal protective equipment are always incurred. It is to be expected that further costs will arise due to the possible underutilization of the crew. As working with mooring lines is a risky activity, well-trained personnel and an appropriate insurance are required.

Mooring with a ship-based crew could be done in different manners. The decision was made to investigate boarding the crew at a boarding pier within the port and or a vessel to vessel transfer before the VT enters the port.

Boarding pier within the port

With this type of boarding, the FV will visit a fixed location in the port so that the mooring team can get on board. Whether a FV has to temporarily moor at the pier for the takeover of the persons should depend on the respective location as well as on the prevailing weather conditions in the individual case. The safest option is certainly to moor with lines at the pier.

The use of a pier inevitably results in having a fixed location in the port area. In a widely ramified port, different boarding piers would have to be set up to serve all terminals or port basins. The use of the port infrastructure causes costs that will not be incurred in other cases. In addition, the costs for a shuttle car transporting the mooring team between the various boarding points in the port have to be taken into account. The mooring team will not disturb the terminal operation.

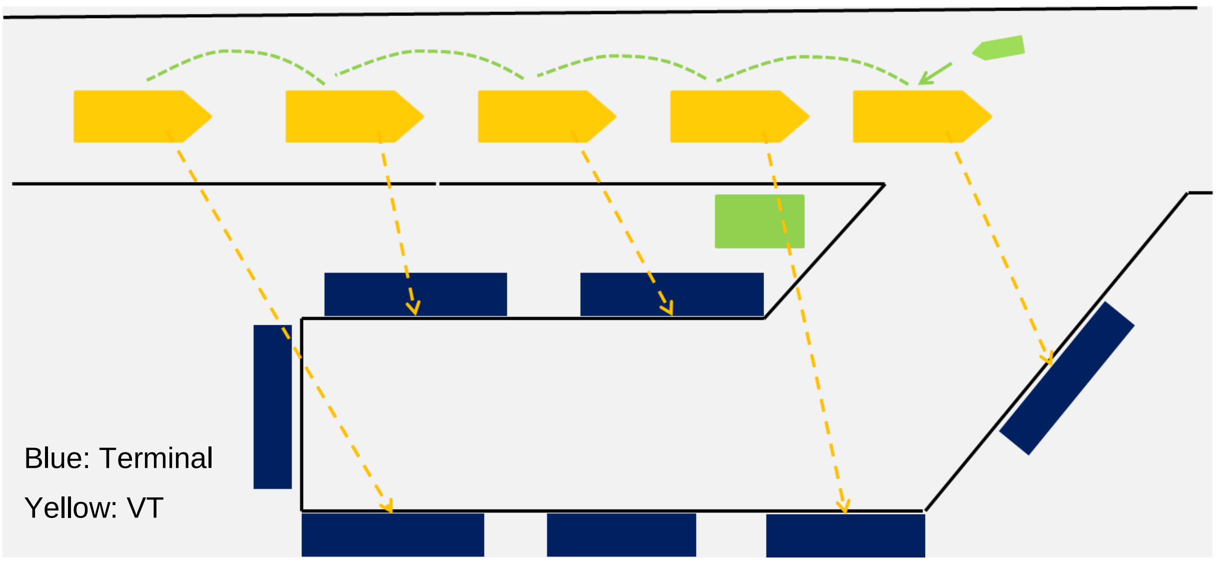
Ship-to-ship transfer before FV entering the port

Depending on the number of terminals to load or unload at the port and the number of vessels connected in a VT, a smaller vessel shuttle service could organize the transport of the mooring crew to the FVs (see figure 3). If the shuttle service would be done one after another, the waterway fairway could be blocked. To overcome the problem of blocking the waterway fairway, the mooring crew should be distributed in a short time. This service is flexible in time and place but needs additional infrastructure. For an arriving VT, an additional vessel with a boatmaster is needed to steer the shuttle vessel. Depending on the number of FVs within the VT, an additional person per vessel seems to be needed to assist the mooring operation. Depending on the distances between vessel and the terminals and therefore the time needed between entering the vessel and assist the mooring operation, it would be possible to pick up the additional crew and give a transfer to another vessel of the VT. After assisting the mooring operation, the additional crew could be picked up by the shuttle vessel or a land-based shuttle is needed.

The main advantage of this approach is that terminal operations are not disturbed, the waterways at the port are not blocked, and the blocking of the water way fairway is reduced or avoided.

This variant is not location-bound and therefore more flexible than enabling boarding at a particular pier. By using a small transfer boat, the team can get on the FV almost anywhere after ordering the mooring service. In addition to the mooring man, one additional person is needed for the operation of the transfer boat. The costs for the construction and maintenance of the infrastructure of the boarding pier variant are eliminated and replaced by the costs of the transfer boat and the additional personnel costs for the operation of the boat. With this type of mooring, the terminal operation is not disturbed by the arrival of the ship.

Figure 3: Vessel to vessel mooring crew transfer before entering the port



For every arriving VT, the following equipment and personal is needed:

- one shuttle vessel and a berth for the shuttle
- one boatmaster
- one additional crew member per each vessel of the VT (perhaps this could be reduced depending of the number of vessels in the VT, see above).
- optional with additional costs: land-based shuttle service, then an additional car with driver is needed

Because of the restricted number of terminals and the loading or unloading times, the number of arriving VTs should be small or one. This will result in a staff utilization rate of well below 100%.

Land-based mooring crew

A land-based mooring crew is notably not dedicated to a specific ship but may also operate beyond a specific berth, terminal, or single port. The crew is very flexible regarding the time and area of their operation. The utilization of the staff is determined by

- the relation between the operation time on the one hand and
- the waiting and relocation time on the other hand.

The waiting time is inversely proportional to the amount of orders which can be acquire for the crew within a specific period. The amount of orders again is not only dependent on the competitive situation of mooring service providers but also on the demand by skippers based on their frequency of calls within the operational area of the mooring crew.

The minimum required relocation time is dependent on the size of the area of operation of the crew, the distance between two successive locations of operation and the road traffic conditions between these locations.

At present, such land-based mooring crews are mainly focused on big port areas with a high number of calls of vessels, mainly big ocean-going vessels. The waiting time is consequently minimized as well as the relocation time because the distance between the berths within a port are limited and no public roads with congestion have to be used.

The VT concept would require mooring crews operating on a much bigger area within a region covering several berths, terminals, or ports. To make such crew operation economical viable and operationally reliable,

- the berths successively served need to be as close as possible to each other and
- the road traffic conditions may allow the reliable relocation of crew within the scheduled time.

ETA, notably in case of serious delays of dozens of hours, needs to be provided by the vessel to the land-based crew to reduce waiting time on-site. If calls of vessels are infrequent at smaller ports and distances are higher between port of calls along the waterways, the economic efficiency may not be achievable.

With a land-based mooring crew, unlike the terminal-based mooring crew, the terminal operation is not disturbed as there is no interdependency between two type of operations relying on the same crew. A land-based mooring crew has the full expertise on mooring procedures and technologies, which reduces the risk of inadequate handling as in case of a crew which is not providing mooring service on a regular basis (e.g. by a terminal-based mooring crew). Each mooring crew require a road vehicle and safety equipment (personal protective equipment) for each member of the crew. As the vehicle is the base for the operation for the crew, not each crew require an office but only the manager of the mooring service. Arrangements with the terminal operations have to be made to get access to the terminal area and use the terminal social and sanitary facilities. Liability issues must be clarified, and suitable insurance must be arranged. In case the service of the land-based mooring crew is required at mooring dolphins, at a mole or at a cargo transfer platform (preferably by terminal-based mooring crew) with no land access a shuttle vessel or mooring tug needs to be provided to transfer the mooring crew to the cargo vessel.

Cost of assisting FVs with mooring

As with any business both investments, its depreciation and operational costs have to be covered. The investments cover vehicles (boats and road vehicle), office and break room, safety equipment and training costs. Depreciation, with a linear deduction, for vehicles is 30 years, for office and break room as well as for safety equipment 10 years. There is no depreciation for training costs, which is calculated on base costs per training hour summing to 80 hours per person. Operational costs include those for energy per hour (fuel for shuttle vessel and road vehicles), maintenance per year (of shuttle vessel and road vehicle), insurance (for equipment and personnel) and personnel (mooring worker, steering man and manager).

For each type of mooring operations, the relevant cost items are allocated as follows:

- ***Terminal based mooring crew***

Investments will be done by the terminal operator into equipment which is already required for terminal operations, notably road vehicle, office and break rooms as well as safety equipment. Therefore, only part of these costs can be charged to the FV operator for mooring operations. Training costs are those specifically for training of the terminal personnel to provide mooring service. Operational costs consist of fuel and maintenance costs for the road vehicle, insurance and personnel costs of the mooring crew. Personnel costs can only be charged partly to the FV operator for mooring operations, e.g. on an hourly basis.

- ***Ship based mooring crew - Boarding pier within the port***

Investments will be done by the mooring service provider into equipment consisting of a road vehicle to be able to approach the boarding pier, office and break rooms as well as safety equipment. If there is no pier, which already exists serving other purposes and can be used for boarding as well, the significant investment in the construction of the pier has to be included. Training costs will not be taken into account as the crew are mooring specialists. Operational costs consist of fuel and maintenance costs for the road vehicle, insurance and personnel costs of the mooring crew.

- ***Ship based mooring crew – Ship to ship transfer before FV entering the port***

Investments will be done by the mooring service provider into equipment consisting of a shuttle vessel to be able to approach the FV as well as safety equipment. Training costs will not be taken into account as the crew are mooring specialists. Operational costs consist of fuel and maintenance costs for the shuttle vessel, insurance and personnel costs of the mooring crew and, if staying on the shuttle vessel throughout operations, a boatmaster.

- ***Land based mooring crew***

Investments will be done by the mooring service provider into equipment consisting of a road vehicle to be able to approach the berth of the FV, office and break rooms as well as safety equipment. Training costs will not be considered as the crew are mooring specialists. Investments in a shuttle vessel may come in addition if the mooring service has to be provided to a FV berthing at a cargo transfer platform. Operational costs consist of fuel and maintenance costs for the road vehicle, insurance and personnel costs of the mooring crew.

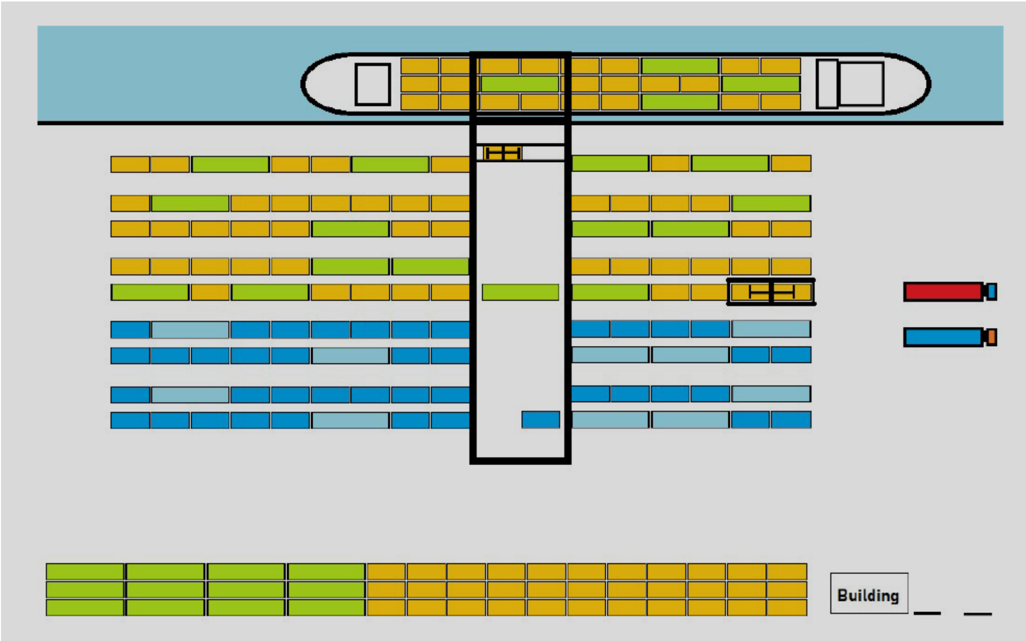
5.2.3.5 Small inland container terminal

A main advantage of the VT is that it enables waterborne transport to access smaller waterways, terminals and urban areas, while at the same time it provides economies of scale effects. However, the main issue of the small inland container terminals is their financial feasibility since the throughput is low. Benedictus-Kortenhorst (2019) conducted a research with the objective to determine the financial feasibility of a small container terminal concept developed for low throughput. This research is of high importance because it stimulates inland shipping, which has lower negative welfare impact than road transport, by determining the design and functional requirements of a small container terminal at a capillary waterway and by evaluating the financial feasibility of such a design. The primary functional requirements identified are the following: 1) size of a small inland vessel to be 95 x 9.6 x 3.0 m (class IV) or smaller, with a maximum carrying capacity of 10 x 3 x 3 TEU, 2) required capacity of the terminal to be 15,000 containers per year, based on the size of the vessel and the number of calls and 3) terminal to be able to perform all transhipment operations and stack at least 180 TEUs. The secondary functional requirements found are the following: empty container depot, long-term storage, consolidation and operations back-up. Taking into account these functional requirements, the design of the small inland container terminal is made. For the design of the terminal, also the equipment that is used in the terminal is taken into consideration, being the crane equipment (different types of cranes) and the vehicles, such as the straddle carrier, reach stacker etc., with the former ones requiring the highest investment, ranging between 1 and 7 million euro. Other types of equipment are also taken into consideration, such as conveyors, elevated transfer vehicle, scissor lift, container side-loader for trucks and mooring winches.

Taking into account these types of equipment and the functional requirements, 11 different design concepts of small container terminals are developed, for each of which an estimation of their cost is made. The calculated costs include estimates of the investment, maintenance, labour and fuel cost, without including an overhead. One of these 11 design concepts is found to be the most promising in terms of financial feasibility, being the straddle carrier concept with the extended overhead crane with a cost of 23.52 euro per container, when dividing the calculated costs with the annual throughput of 15,000 containers. This concept is found to have a positive net present value (NPV) of 193,000 euro at a transhipment rate of 55 euro, which is 15 euro above the market price and an internal rate of return (IRR) of 3.45%. This design concept is found to be even more beneficial in financial terms, when additional functions are added in the terminal, such as storage or an empty container depot. When adding the storage functionality at the terminal, the NPV almost doubles, and when adding the empty container depot functionality the NPV more than quadruples. If annual throughput increases, then this contributes to the decrease of the transhipment rate, which is defined at 55 euro for an annual throughput of 15,000 containers.

The proposed small container terminal design concept is shown in the figure below. Figure 4 shows that there are five parallel to the quay rows of container stack and a land dimension of 148 x 40 m. A building has been also added for the various overhead functions and also there is a manoeuvring room for the straddle carrier on both ends of the stack and for trucks on one end. The long term storage functionality is shown by the four blue rows of containers that are added. The empty container depot is located at the edge of the terminal, furthest from the water, to avoid conflict with the existing stack.

Figure 4: Top view of proposed terminal layout including long term storage and empty container depot



5.2.4 Results sub-task 2.3.1 (Initial VT variants)

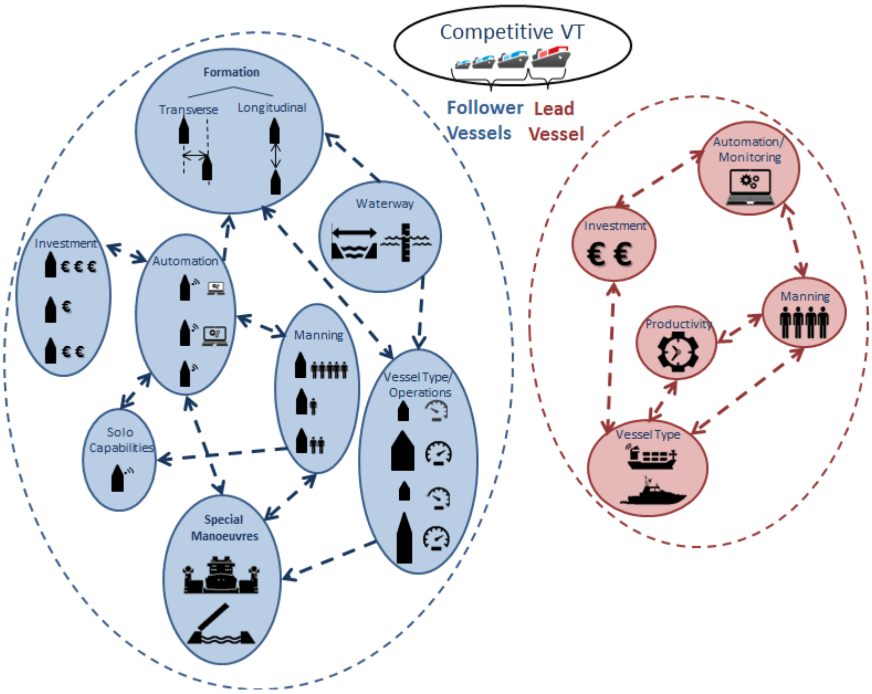
The variations of specific properties may cause the VT to exhibit different behaviour. The analyses of these variations allows researchers to obtain an understanding of the importance of each individual VT features. The larger the impact of the feature on the economics of the VT, the more important this feature becomes in the determination of the economic viability and thus in the identification of the boundary conditions of the concept.

This section identifies the properties of the VT and elaborates on these features are composed of. This is followed by the identification of the most relevant initial variations that are identified as being part of the mid-term review. Finally, a brief description on the approach of the analysis of these variations within the BMs is provided.

5.2.4.1 VT Features and variation options

The research scope restriction from deliverable 2.1. (Hoyer et al., 2017) identified earlier in this project, can be viewed as first stage variations. Figure 5 is an elaboration of that information. It presents all features that have a technical impact on the VT concept and thus also on its viability. The features can be split into two categories, the first relating to the properties of the LV and the latter on the properties and interactions of the FVs.

Figure 5: VT Features that are the Bases for the Variations in the Analysis



The following descriptions of the VT features state the relations of the features to each other and emphasises the relevance of each feature for the overall VT. The descriptions clarify how variations in these features can be used to create iterations of the VT concept design and improve the viability of the concept.

5.2.4.2 LV Features

Vessel Type

The LV can provide different services by solely focusing on the task of leading vessel in a train, thereby making it a dedicated LV. The alternative is using a cargo transportation vessel that has and additional income through providing leading services on top of its standard income from transporting cargo. These vessels can end up being of different sizes which influences the operational cost the LV.

Investment

The investment cost of the LV can vary dependent on the BM, in two different manners. One is related to the variation of VT technology cost and the other is related to the capital cost of the construction of a new LV. The investment cost for the VT technology is determined by the development output of WP3 and is applicable for all LVs. The capital cost of vessel construction is not applicable for all business cases. The cargo LV for instance can be refit from an existing cargo vessel and would thus require no or very little construction cost compared to a dedicated LV that still needs to be built. The investment cost influences the insurance and depreciation cost of a vessel and is thereby a possible limiting cost element for the determination of the viability.

Automation

The level of automation is influenced by the capabilities of the technology development. It may be at investment restrictions are set at later stages of the development that identify a maximum investment cost that cannot be surpassed. On the other hand, if a minimum crew reduction requirement is set instead, then the type of automation built in on board of the vessel may be force to be enhanced.

Manning

The manning level on board of the vessels (are) influence(d) (by) the operating time of the vessel. All shifts during the vessels operations have to be filled. This relates to the automation level on board that can dictate the tasks load of the crew. The VT technology may require higher crewing levels to allow monitoring of the FVs. The crew levels for general operation of the dedicated LV may vary dependent on the size of the LV.

Productivity

The productivity refers back to the LV type. It also relates to the waiting time choices made for the BMs. A cargo LV will be spending a smaller proportion of its time leading compared to a dedicated LV, since it is required to spend time in port to (un)load cargo. Furthermore, waiting times created by departure or special manoeuvre procedures can also reduce the productivity of the LV. This reduction in productivity is applicable to the entire VT, thus also the FVs and not only the LV.

Table 9 summarizes the possible variations opportunities for each of the described LV features.

Table 9: LV Feature Variations

LV Features	Variations	
Vessel Type	Dedicated	Cargo
Investment	Ship Cost	VT Tech Cost
Automation	VT Tech	More tasks on board
Manning	Operating Crew	Monitoring Crew
Productivity	% of time spent leading	

5.2.4.3 FV Features

Vessel Type

Determining the most appropriate vessel type combinations for the VT, is an important step in studying the behaviour of the concept. Different loading condition, that influences the draft of the vessels, but also the variety of vessel properties affect the VT operations. The operating speed of the VT is determined by the slowest member of the train. Varying the vessel types in simulations is needed to determine which vessel types may or may not be combined in the same VT.

The variation in vessel types also include the variation in the cargo they transport. The main two forms of cargo that have been decided upon are roro and container cargo both with hazardous and non-hazardous cargo. The reason why the cargo type is considered an important variation is that not only the demand requirements differ but also operational tasks on board can change with a difference in cargo that is loaded.

The diverse power capabilities of the FVs also have an effect on the safety distances between the vessels and potentially also on the order in which each vessel type is to follow the LV. This is directly connected to the formation feature of the FVs.

Special Manoeuvres

Special manoeuvres are mainly restrictive for the inland sector. The special restriction will require procedure to be put in place to allow the VT to navigate the waterways without significantly disrupting third party waterway users. Such procedure concerning lock or bridge passing, but also any type of encounters with other vessels, will create waiting times for the VT. This waiting time is dependent on the VT length, the size of FVs and the procedure used to get the entire VT across. The procedures, in turn are directly influenced by the size of crew and the level of automation on the FVs. The determination of a maximum waiting time for a certain VT length allows the identification of routes that may be more appropriate for the VT use.

Automation

The automation requirements for the FVs are very similar to the LV requirements. As it looks, the technology will likely be the same with a follower and a lead mode. This means that this automation feature influences the investment and manning requirements. The VT technology on its own only intents to automate the navigational tasks. Conclusions may be drawn at a later stage of the project, that a higher level of automation, also covering other tasks than navigation, may be required to allow a larger crew reduction on the FVs and only then allow the concepts viability.

It may also turn out that the VT technology is a limiting factor, since the communication range between vessels can create a physical limit to the VT length that could be smaller than the minimal length of economic viability.

Manning

The reduction in manning form the current state of operations, is the main cost advantage for the vessels that join the VT. The variation of crew reduction is therefore made the most crucial aspect in the viability assessment. As mentioned in the last paragraph, the manning is directly linked to the level of automation on board. The VT technology alone only eliminates the navigational tasks during the period in which the FV sail in the VT. All other tasks still need to be performed, in the same manner than they are currently done. It can therefore be expected that only few crew members can be taken off board. Kooij and Hekkenberg (2019) expect this to reach up to three crew members on SS vessels. Inland vessels, with smaller crew than SS ships, may on the other hand not be able to reduce any or very few crew members. In these cases, the FV can still gain a benefit in using the opportunity to rest the crew during the sailing in the VT. This allows the vessel to operate for a longer period of time once it leaves the VT. The variation of the resting periods becomes hereby the main variation point for the inland vessels.

The viability analysis will result in a recommendation of a minimum crew reduction requirement. It may be that the required crew reduction is higher than the reduction that can be achieved through the automation of the navigational tasks. If that were to occur, one would have to consider other form of automation can be brought on board in order to further reduce crew tasks.

Investment

The investment cost feature for the FVs is comparable to the one of the LV, with the exception that no ship construction cost are being assumed. The FVs are expected to be refit vessels and will thereby not have any major construction costs.

Waterway

The waterway or rather operational sector restricts the type of vessels that can sail on them. As seen from the descriptions of the other FV factors, the behaviour of the VT may indeed demonstrate different viabilities dependent on the sector it offers its services to. When considering the possible variations that a choice in waterway affects, one can identify technical but also demand dependent variations.

On inland waterways technical aspects such as the shallow water effect, have an influence on the operational cost if the vessels. Additionally, geographical aspects alike bends in the river, limits the visibility between the LV and the last member of the train. These special restrictions hence also sets a technical limit on the maximum VT length.

Formation

The formation of the FVs is composed of the transverse and the longitudinal element. Both of these formation features are dependent on the waterway that is being sailed on. DST (2017) has performed model test that show the changes in power requirement dependent on the transverse and the longitudinal distance of the FV to the vessel ahead. These test show both positive and negative effects concerning the close range sailing. These results are however demonstrating distances below one vessel length, which from a safety aspect is not an acceptable distance. The variation of these power requirements is hence not considered a determinant feature of the concept. Instead, the main variance for the formation feature lies in changes of the safety distance between vessels since that may cause the VT to surpass the technical maximum VT length.

Solo capacity

The last characteristic of the VT application is the solo sailing capacity of the FVs. As the FVs are manned, the crew takes over full responsibility of the vessel once it leaves the train. The crew needs to be capable to sail the vessel for any given distance before it joined and after it joined the VT. The solo capabilities are affected by the crew level on board. For the inland vessels this means the amount of the resting periods for the crew while in the VT. Having a rested crew at the point of decupling, will allow inland vessels to have a full sailing regime worth of time to reach its final destination. Table 10 summarizes the possible variations opportunities for each of the described FV features.

There are two VT variations that do not fall under any of these described features, since they are related to the cash flow between the stakeholders. Dependent on the BM, the service may be used and provided by a single stakeholder, which means the costs and benefits created are shared for the entire VT, as seen in the example of case study 3. The opposite but alternative approach would be that each stakeholder acts as an individual interest for their cost and benefits, which means similar to case study 2.

As described in the descriptions of the BM in the earlier chapter, the method in which the VT user pay for the services can also change, either asking for a lump sum payment for participation or a cost plus mark-up payment. The variation of the mark-up allows an identification of the maximum profit that can be made by the VT operator. This mark-up will change dependent on the number of FVs in the train. The fixed lump sum is independent of the number of vessels in the train, it is either set on a trip or distance joining bases.

Table 10: FV Feature Variations

LV Features	Variations	
Vessel Type	Vessel with different speed capabilities	Vessels with different cargo (container or RoRo)
Special Manoeuvres	Waiting times	
Manning	Crew level reductions	% in resting periods
Automation	Navigational Tasks	More tasks on board
Investment	VT tech cost	Further automation cost
Waterways	Area of Operation (SS, IWT, S-R)	Demand requirements (different O-D)
Formation	Safety distances	
Solo capacity	% time spend sailing alone	

5.2.4.4 Initial variation

The previous section demonstrated a number of variations possibilities. Not all of these are of equivalent importance for the first stage assessment, done in order to access the concept for the mid-term review. The most important initial variation are identified to be:

- LV Type
- LV Investment
- LV Manning
- LV Productivity
- Waterways both SS and IWT
- Different FV sizes , thereby creating VT compositions of alike and dislike vessels
- Waiting time at locks and at ports
- FV crew level reduction
- FV crew resting times
- VT tech cost

5.2.4.5 Approach to variation analysis

To allow an understanding to be formed of the variation effect of each VT features, direct and fair comparison between them has to be done. To allow such a comparison a base case has to be set that allows each variation to be performed individually. Once such an initial analysis has been performed, it is possible to better interpret simulation results obtained from BM in which multiple features have been altered.

The base case presented in table 11 is representative of the of the case study 1 with the exception that the charging scheme is no lump sum, but rather assumes the coverage of the LV cost only. This is representative of a close to best case scenario, for the individual users, or a situation in which a company provides this service for its own vessels.

Table 11: Base Case

Business Model	**Liner**
Stakeholder Benefit	Individual
Lead Vessel	Dedicated
Charging scheme	Compensation for the trip cost of LV
Investment	3 000 000[11] (LV construction) 80 000[12] (VT Tech for LV and FV)

[11] HOEKSTRA, T.J. (2014), Optimizing Building Strategies for Series Production of Tugs under Capital Constraints, Gorinchem

LV Manning	6 (operating)	3 (monitoring)
LV Availability	90%	
FV Type	All FVs of the same type	Containers (non-hazardous)
FV Special manoeuvres	No waiting time created	
FV Manning	Crew member reduction (1-3)	No % resting time
FV Formation	Safety distance (one ship length)	No transverse formation, vessel follow in a direct line.
FV Solo Capacity	No solo sailing assumed	

5.3 Development of the cargo consolidation IT-Tool

5.3.1 Introduction

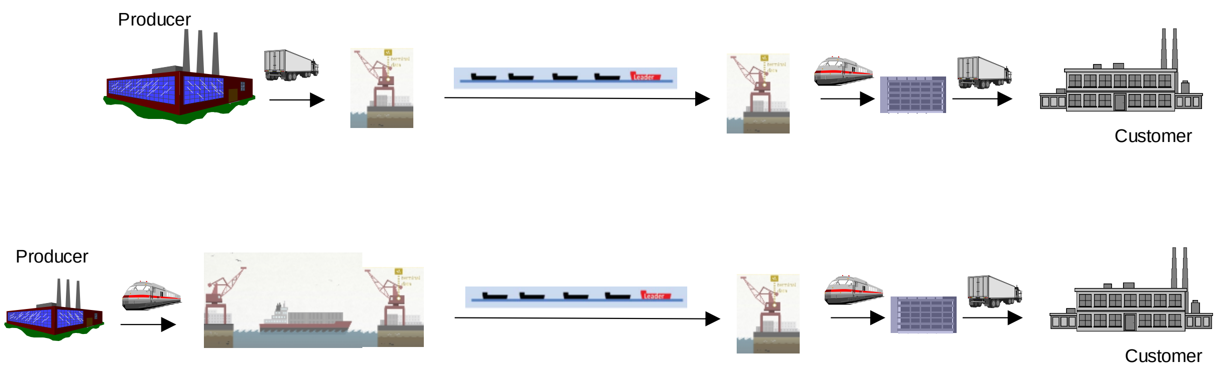
This sub-section is split into 2 sub sections. This first section deals with the development of the ToR for the cargo consolidation at ports. The second part deals with modification of the Marlo-IT tool.

5.3.2 Results sub-task 2.3.4 (ToR cargo consolidation)

5.3.2.1 Introduction

In the NOVIMAR Deliverable 2.2, the logistics scenarios illustrated in Figure 6 formed the basis of describing the various capabilities needed to properly manage the relevant door-to-door transport operations where vessel trains are being used for intra-European movement of freight on water.

Figure 6: Logistics chains including NOVIMAR vessel trains



[12] Expert opinion from the developers of the VT technology witin NOVIMAR. (these experts are from Argonics and Innovative Navigation Gmbh

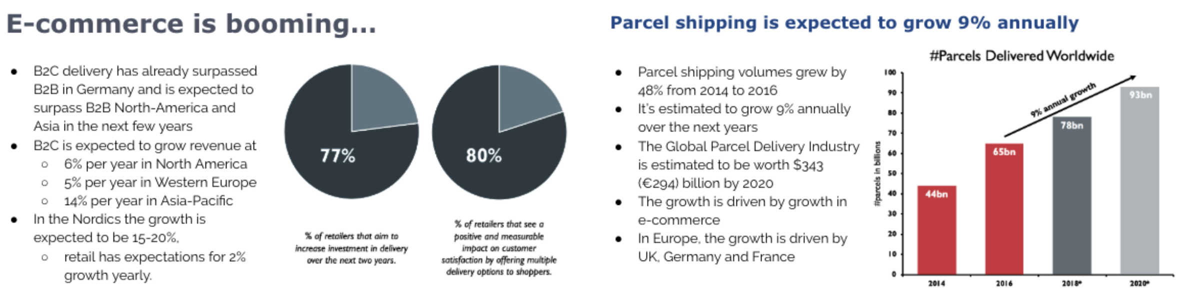
The logistics chain on the top illustrates an intra-European logistics chain, while the one on the bottom illustrates an intercontinental logistics chain.

To exploit the flexibility offered by the vessel train concept, we need to organise operations in such a way that cargo shall not have to unnecessarily wait for other cargo to be loaded or unloaded. To achieve this, a special consolidation (or sorting) process need to take place in all loading ports, such that "all cargo in one vessel has the same discharge port.

However, when allocating cargo to vessels in the vessel trains, we need to make sure that all vessels are properly utilised. We therefore need to be able to add capabilities to the consolidation process, such that some cargo may be kept in the port terminal in order to ensure that vessels serving a special port is filled as much as possible before entering a vessel train. Such intermediate storage needs to be supported in the ports.

To a large degree, the growth in container transport is driven by the growth in eCommerce; see figure 7.

Figure 7: Volume growth due to increased eCommerce.

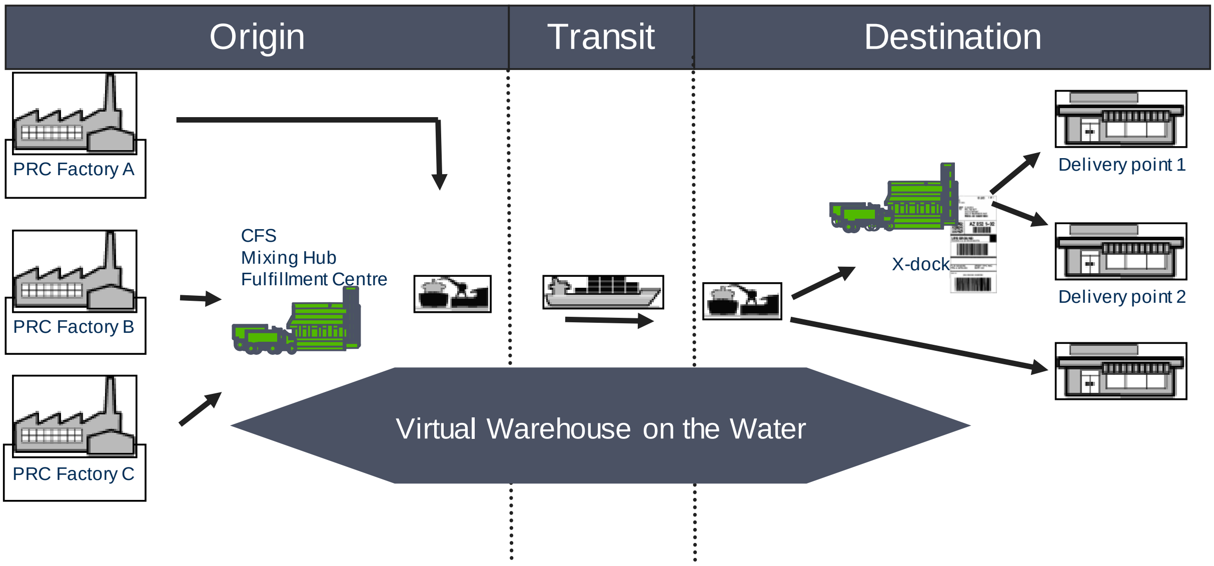


Currently, there has been a tendency to clearly distinguish between B2B and B2C operations in logistics, since eCommerce need to be fed by providers and distributors.

Even though a large part of NOVIMAR is dedicated to vessel train operations, it is important to ensure that these operations also will be attractive in the growing eCommerce environment. In addition to the capabilities described in Deliverable 2.2, one extra aspect will be included in the NOVIMAR logistics management solution.

eCommerce is typically offering short delivery times from online order to fulfilment. Amazon is now investing 800 million USD to support 24-hour delivery of orders (seems limited to the USA at the moment, but driving the businesses in the rest of the world as well). It is not for others to be able to invest similar amounts. The solution is to work smarter and to be able to use all cargo in the supply chain, in terminals and "on the move" in "floating warehouses", as a basis for fulfilment, not only cargo in warehouses close to customers; see Figure 8.

Figure 8: "Floating warehouses"



As a consequence, the capabilities described in Deliverable 2.2 will be supplemented with the following functions for being able to provide fulfilment based on all cargo available:

- Have full visibility of all cargo, either on the move, in terminals or warehouses. This means making information about cargo and its whereabouts continuously to consignee or consignor.
- Be able to receive information about new destination for any logistics unit and to redirect it to the new destination. Consignee or Consignor may choose to change destination, if that is needed to fulfil buyer-seller obligations.

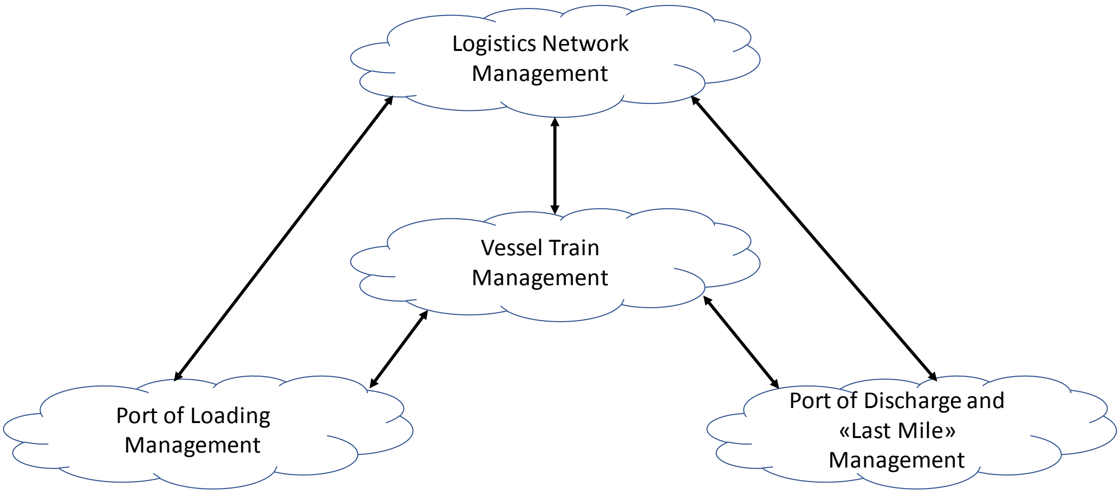
5.3.2.2 Relevance for diagrams

The functional diagrams for all operations related to activities in the Port of loading and port of discharge, plus handling vessel train operations are presented again in appendix D.

The scope of the capabilities required covers all that is necessary to move goods through a network of logistics services, where the vessels participating in vessel trains perform some of the services in the network.

In Deliverable 2.2, the hierarchy of ICT systems needed to manage vessel trains was illustrated as shown in figure 9.

Figure 9: Logistics management capabilities involving NOVIMAR vessel trains



The key differences between what was described in Deliverable 2.2 and what is known as this time are:

- The dynamics related to information about incoming cargo and change of destination will essentially happen at the Logistics Management level. It will not impact the functions described in the functional diagrams describing port operations or the operation of vessel trains.
- As indicated in the text above, it may be necessary to keep some containers in the port of discharge to make sure that vessels joining vessel trains are properly filled. This capability is not present at the level of detail in the functional diagrams in Deliverable 2.2, but would be visible if the function A6 "Allocate cargo to vessels" in Figure D.1 (see appendix 9.4) would have been decomposed further. Here we need to make sure that if a container is allocated to a vessel not arriving immediately when the cargo is available, then it will have to be kept in the port until the appropriate vessel is available.
- The same this as also relevant for other logistics units. If logistics units cannot be reconstructed to immediately fill a container, then they need to be kept in the port of loading until there is enough cargo to fill a container.

The last two bullets above may show that some cargo may be late if there is not enough cargo to fill containers or vessels. Such intermediate storage will only be executed if the cargo will still arrive at the current destination as agrees between consignee and consignor. If that is not the case, then the logistics management system will enable use of other logistics services.

5.3.2.3 Terms of reference related to the development needed to fulfil NOVIMAR obligations

Background

The starting point for the development of the logistics management functions required in NOVIMAR is the system currently called MIXMOVE Match. It was developed in the iCargo project and is being used to manage the logistics network of 3M in Europe. The logistics units dealt with in the current operations are: parcels, pallets, containers and trailers (trucks).

The transport mode of transport, with one exception, in the 3M network is road transportation, no platooning. Hence, the functions needed on NOVIMAR will build on MIXMOVE Match and deal with all the specialities needed for NOVIMAR operations.

The way that these developments will be performed is that the special NOVIMAR requirements will be used as **the** reference, but the capabilities will be implemented in such a way that they may be used also in other contexts.

Port of Discharge

The extra capabilities needed to fulfil NOVIMAR obligations are:

#	Description
1	Port of Discharge need to be identified on the basis of information about the final destination of cargo and transport services available to get cargo from port to final destination
2	The operator needs to be able to store LCL cargo in case it is not possible to fill a container with cargo having the same discharge port
3	Information about which cargo is stored in port of discharge needs to be provided in a form that enable consignees or consignors to use the cargo there as a basis for fulfilment.
4	It must be possible to receive information about vessels and vessel trains and their schedules
5	It must be possible to keep containers in the port of discharge if it is not possible to fill a vessel properly
6	Allocation of cargo to vessels need to be such that the vessel-capacity is not exceeded.
7	Reconstruction need to take into account that container weights cannot exceed the maximum allowed.
8	Information about cargo in containers needs to be provided in a form that enable consignees or consignors to use the cargo there as a basis for fulfilment.
9	Provide information about which containers are allocated to which vessels
10	Provide information about cargo actually loaded into containers in a form that enable consignees or consignors to use the cargo there as a basis for fulfilment and for managing

	the logistics operations
11	Provide information about containers actually loaded onto vessels in a form that enable consignees or consignors to use the cargo there as a basis for fulfilment and for managing the logistics operations

Joining a Vessel Train

The functions needed to achieve this are:

#	Description
1	Search vessel train schedules to identify the proper train
2	Book a slot in a specific vessel train by sending a request to the vessel train operator. If the vessel train is not confirming the request will be saved but marked “not accepted”
3	Plan departure by providing all relevant information to the vessel train and possible port crew and to relevant authorities.
4	Other requirements may arise, as these capabilities are developed

Vessel train Operations

The functions needed are as described below. They will be implemented in such a way that the system will also be able to manage platoons of trucks.

#	Description
1	Describe and publish vessel train schedules
2	Describe and publish transportation services provided by the vessel trains
3	Receive bookings from vessels to join vessel trains – also describing when the vessels aim to leave the vessel train
4	Accept or reject bookings
5	Keep track of vessels that have joined and are leaving the vessel trains in a form that enable consignees or consignors to use the cargo there as a basis for fulfilment and for managing the logistics operations
6	Continuously monitoring and reporting vessel train progress and calculation of relevant ETAs

7	Other requirements may arise, as these capabilities are developed

Port of Discharge

No extra capabilities are required to support activities in the port of discharge.

5.3.3 Results sub-task 2.3.5 (Modify Marlo IT-Tool)

As descripted in section 4.3 the results of this tasks will be given as a separate deliverable (D.2.3.b) which is due at the mid-2020. This deliverable will contain the detailed description of the adjustments that are made to the Marlo-IT tool based on the ToR defined in T.2.3.4.

5.3.3.1 Introduction

The purpose of Task 2.3.5 in Novimar is to develop and demonstrate solutions for managing the flow of goods using vessel trains. This document illustrates the use of the software that has been developed in a given scenario.

5.3.3.2 The scenario used

The Vessel Train logistics management software will be demonstrated using a scenario on the river Rhine. The Train in question will start in the Port of Rotterdam. Cargo will arrive both from intercontinental container operations and from short-sea shipping.

The lead ship will carry cargo and is destined to serve the Port of Basel.

Between Rotterdam and Basel, the Vessel Train will serve Duisburg and Mannheim, see figure 10.

The following lead and follower vessels will be involved:

- The Lead Vessel carries cargo from Rotterdam to Basel
- One follower vessel carries cargo from Rotterdam to Duisburg.
- One follower vessel carries cargo from Rotterdam to Mannheim.
- One follower vessel will join the Vessel Train in Duisburg and carry cargo to Mannheim.

Figure 10 Demo scenario

5.3.3.3 Roles supported

The following roles and functions are supported by the developed software:

- Terminal operator (PoL)
  - Consolidating cargo and
  - Booking container transport
- Vessel Operator
  - Publishing information about vessel services
  - Handling container bookings
  - Book slot in Vessel Train
- Vessel Train Operator
  - Publish vessel train services
  - Handling Vessel Train bookings
- Terminal Operator (PoD)
  - Cross-docking cargo for hinterland transportation
  - Booking hinterland transportation

It is worth noting that the Vessel Operator and the Vessel Train Operator may be one and the same organisation, but the tasks are different when it comes to operations.

5.3.3.4 Structure of the T.2.3.5

There are three types of capabilities that are required for managing cargo flows with vessel trains:

- Terminal Operations (Port of Loading and Port of Discharge).
- Vessel operations
- Vessel train operations.

Terminal Operations

One key to making Vessel train operations attractive is to make sure that lead times for cargo is kept at a minimum. Hence, it is important to make sure that the discharge ports for cargo are appropriate form the point of view of minimising lead times. Discharging cargo destined for Denmark in Basel is the ultimate example of not focusing on lead times.

Consequently, in the Port of Loading (POL), incoming cargo need to be analysed such the appropriate discharge ports for cargo are being used. If this is not the case, then the arriving containers are split and cargo reconstructed, if this is not arranged prior to cargo arriving at the Vessel Train PoL. Once cargo is consolidated, the terminal operator books container transport. (sends booking to Vessel Operator).

In the port of Discharge (POD), we need to ensure that the transport means that leave the port is used properly (carry as little air as possible). Hence, there is a need to ensure that cargo that can move together does that as far as possible into the hinterland.

Descriptions and examples of these operations are presented in the next section.

- Vessel operations

For vessels to be “visible” to potential customers, in this case the Terminal Operator, the Vessel Operator need to make schedules and capacities available. Above this is called “Publishing information about vessel services”.

The vessel operator will also receive bookings and will assign containers to vessels, ensuring that all containers in one vessel have the same discharge port.

Section 4 describes these processes with examples.

- Vessel Train operations

The schedules of vessel trains (lead vessels) need to be available to the vessel operators. On this basis they may be able to book a slot for a vessel that is ready to move. The Vessel Train operator will confirm or reject the booking (no more vessels possible in the Vessel Train).

Section 5 describe these processes with examples.

5.3.3.5 Terminal Operations

Port of Loading

Facilities

The ultimate port of loading for vessel trains are those serving intercontinental container ships, typically Rotterdam, Antwerp, Hamburg, etc. A typical layout of such a terminal is shown in figure 11. The vessels are serviced with quay cranes and containers are stored on the yard area. Hinterland transportation is handled by trucks, trains and inland waterway vessels. These terminals are normally handling full container loads (FCL). Hence, there is no need for setting aside any area for splitting and reconstructing or consolidating cargo.

Figure 11: Conceptual layout of a container port terminal

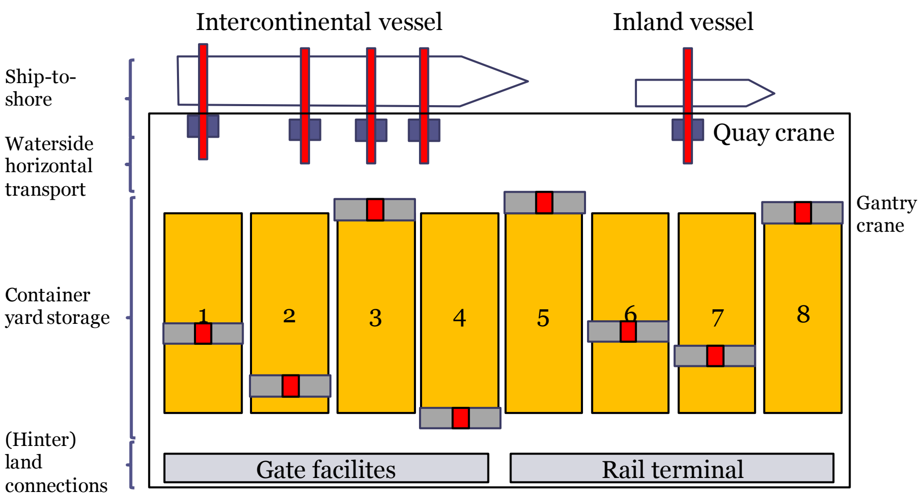
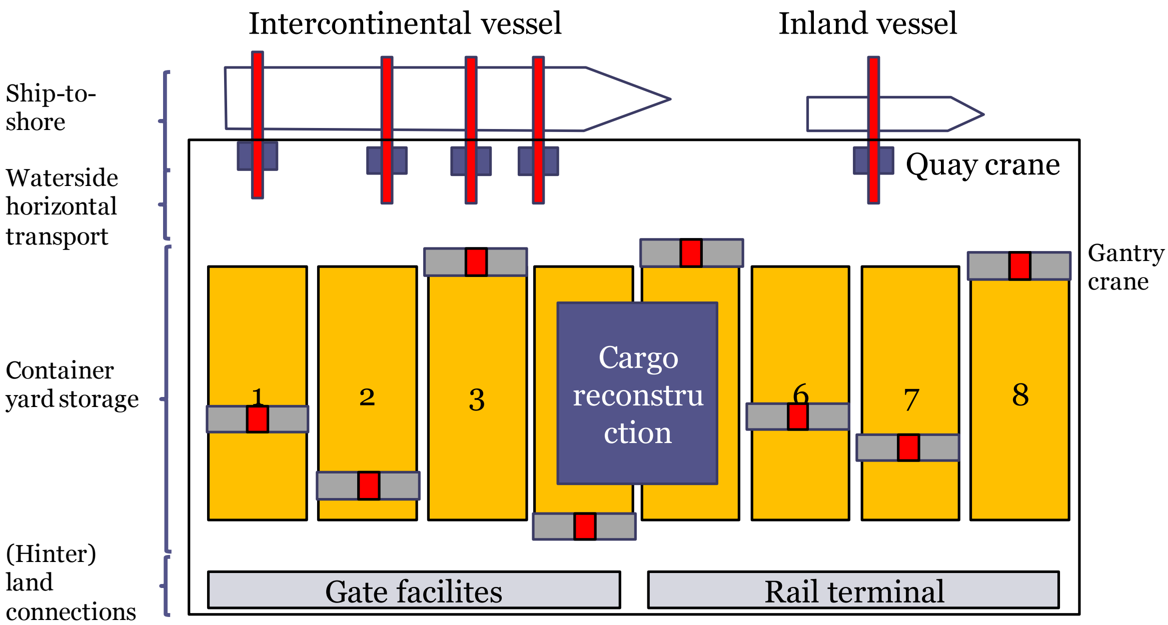


Figure 12 illustrates a conceptual model of a container terminal where a capability for cargo reconstruction, or consolidation, has been added. The key purpose of this illustration is to indicate that such a capability may be added to any terminal operation using existing physical infrastructures and existing information systems. The new logistics process for reconstruction/consolidation and the associated management system (MIXMOVE Match) supplements, not replaces existing capabilities.

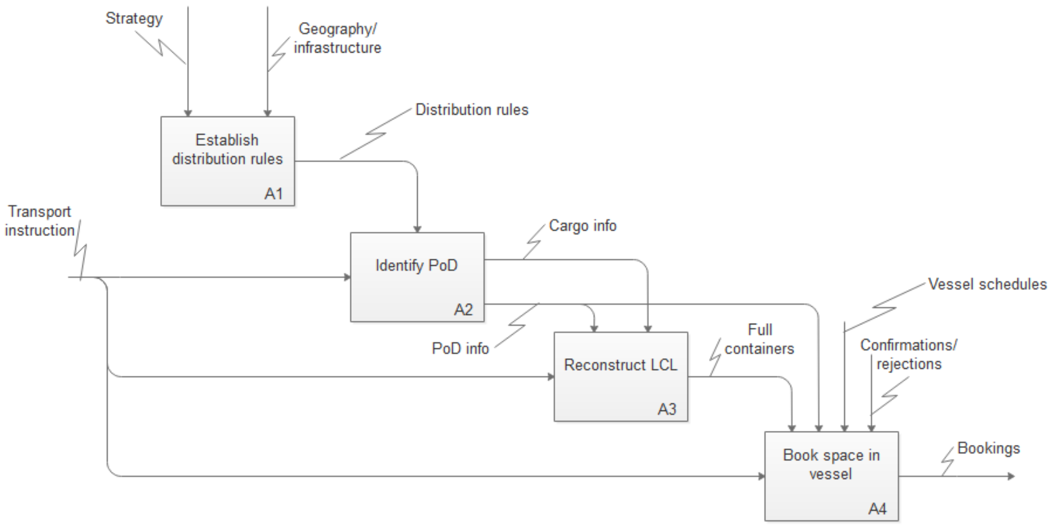
Figure 12: Container terminal with cargo reconstruction added



Functions

The activities in the PoL are illustrated in 13.

Figure 13: Activities in the Port of Loading



The functions A2, A3 and A4 in Figure 13 are managed by the software solution MIXMOVE Match. MIXMOVE Match has not been developed to solely support Novimar activities and operations. It is a generic system for managing cross docking and consolidation/reconstruction processes and adapted to the special needs of the Novimar project.

For the reconstruction/consolidation process to be performed properly, it is imperative that information about the arriving cargo has been received prior to the arrival of the cargo. In figure 13 this is illustrated by the “arrow” coming in from the left, labelled Transport Instruction. The Transport Instruction, in the current version of MIXMOVE Match using the GS1 standard for such messages, is one example of the message that contains

Activity A1 is used to configure the MIXMOVE Match solution to ensure correct decisions, see below.

The functions performed are:

Establish distribution rules. Decisions about how to reconstruct or consolidate cargo are based on a set of rules that is configured prior to start planning and execution of the operations. These rules are configured once but may be changed at any time. Decision rules are described in the section below.

Identify POD. This where the reconstruction/consolidation operations are planned. The decision rules defined in activity 1 are used to identify POD and to provide instructions to the operators in the cargo reconstruction area (see figure 12) such that all cargo with the same discharge port are reconstructed/consolidated properly in activity A3.

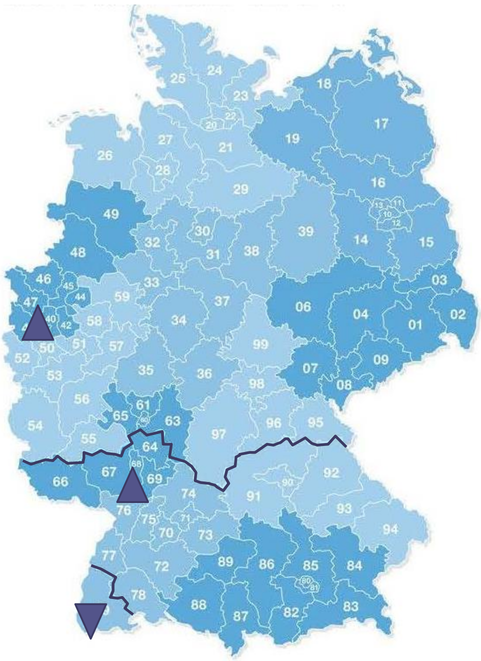
Reconstruct LCL. If all cargo in arriving containers have the same discharge port, then the container is not touched in the port terminal. Only those where cargo in the containers have different discharge ports according to the decision rules will be split and cargo reconstructed and loaded into containers together.

Book space in vessel. Once the containers are fully prepared for inland waterway transportation, booking requests for passage from POL to POD are sent to the operators of the appropriate vessels. Should the booking requests be rejected, the booking process continues until passage is secured.

Distribution Rules

The use of distribution rules is explained by illustrating how containers in the port of loading will contain cargo having the same discharge port. The example will be using post codes, with Germany as an example, see Figure 14. The ports in Duisburg, Mannheim and Basel are indicated in the map.

Figure 14: Post code regions in Germany used to direct cargo to Duisburg, Mannheim and Basel



Seen from the map, and recognising that the cargo is coming via the port of Rotterdam, in this example, it is fair to assume that ports of discharge will be based on the following rules

Cargo to be discharged in **Duisburg**:

Post codes			Countries
From	To		
01000	63999		Denmark
65000	65999		Poland
95000	99999		Lithuania

Cargo to be discharged in **Mannheim**:

Post codes			Countries
From	To		
64000	64999		Austria
66000	78999		Check Republic
80000	94999		

Cargo to be discharged in **Basel**:

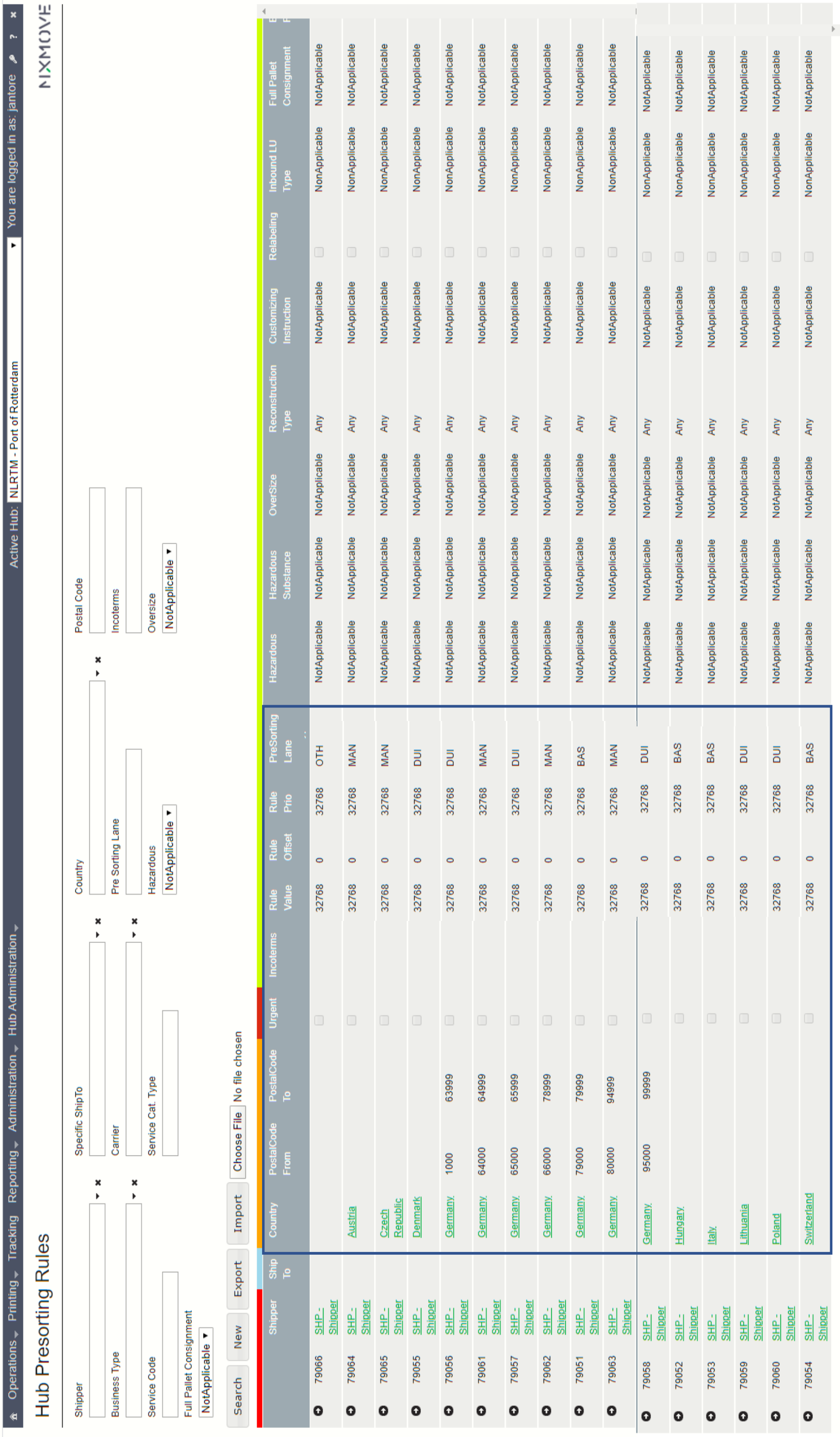
Post codes			Countries
From	To		
79000	79999		Switzerland
			Italy
			Hungary

If other postcodes are more appropriate, the distribution rules may easily be changed, since new distribution rules require no software modifications.

Screenshots for how these rules are implemented in the MIXMOVE Match solution are shown in the marked area of figure 15, where the relevant attributes in this example are:

- Country
- Postcode From
- Postcode To
- Rule Value: Inducates the ID of the rule
- Rule Priority: Indicates which rule takes priority if there are several rules applying
- Pre-sorting Lane: This is where a “lane” or an area has been set aside for cargo to each of the POD, Duisburg (DUI), Mannheim (MAN) and Basel (BAS). In addition an extra area is set aside if the incoming cargo is not properly labelled or has other discrepancies so that it cannot immediately be placed in the appropriate POD area.

Figure 15: Sample decision rules in MIXMOVE Match

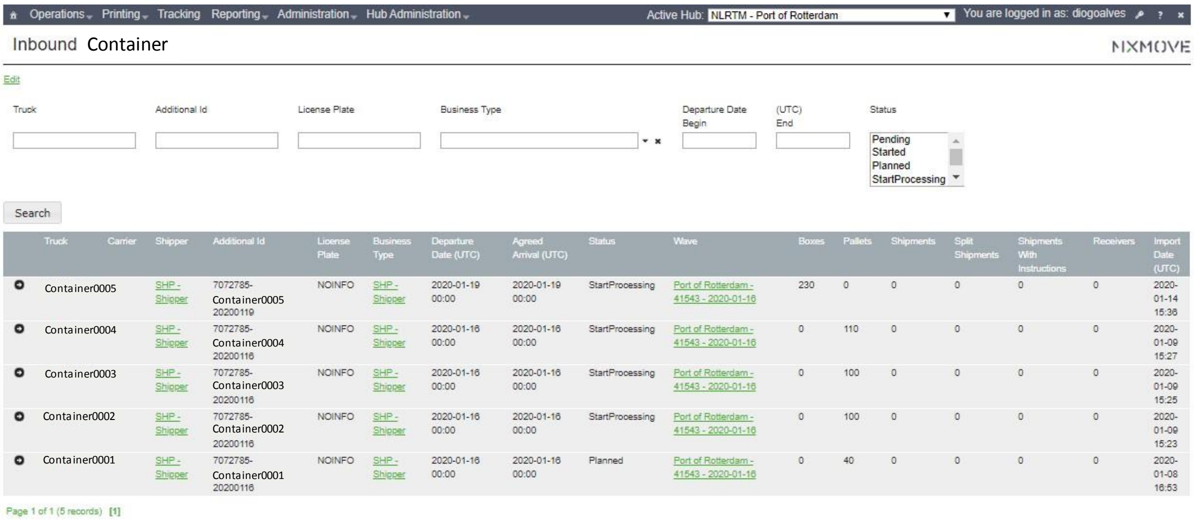


	Shipper	Ship To	Country	PostalCode From	PostalCode To	Urgent	Incoterms	Rule Value	Rule Offset	Rule Prio	PreSorting Lane	Hazardous	Hazardous Substance	OverSize	Reconstruction Type	Customizing Instruction	Relabeling	Inbound LU Type	Full Pallet Consignment
79066	SHP - Shipper							32768	0	32768	OTH	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79064	SHP - Shipper		Austria					32768	0	32768	MAN	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79065	SHP - Shipper		Czech Republic					32768	0	32768	MAN	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79055	SHP - Shipper		Denmark					32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79056	SHP - Shipper		Germany	1000	63999			32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79061	SHP - Shipper		Germany	64000	64999			32768	0	32768	MAN	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79057	SHP - Shipper		Germany	65000	65999			32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79062	SHP - Shipper		Germany	66000	78999			32768	0	32768	MAN	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79051	SHP - Shipper		Germany	79000	79999			32768	0	32768	BAS	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79063	SHP - Shipper		Germany	80000	94999			32768	0	32768	MAN	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79058	SHP - Shipper		Germany	95000	99999			32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79052	SHP - Shipper		Hungary					32768	0	32768	BAS	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79053	SHP - Shipper		Italy					32768	0	32768	BAS	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79059	SHP - Shipper		Lithuania					32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79060	SHP - Shipper		Poland					32768	0	32768	DUI	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable
79054	SHP - Shipper		Switzerland					32768	0	32768	BAS	NotApplicable	NotApplicable	NotApplicable	Any	NotApplicable		NonApplicable	NotApplicable

Planning

As mentioned above, information about the arriving cargo need to be received by the MIXMOVE Match solution prior to the arrival of cargo, such that the reconstruction/consolidation process can be planned. Figure shows how information about incoming cargo is visualised in the solution.

Figure 16 Information about incoming cargo



Truck	Carrier	Shipper	Additional Id	License Plate	Business Type	Departure Date (UTC)	Agreed Arrival (UTC)	Status	Wave	Boxes	Pallets	Shipments	Split Shipments	Shipments With Instructions	Receivers	Import Date (UTC)
Container0005		SHP - Shipper	7072785-Container0005 20200119	NOINFO	SHP - Shipper	2020-01-19 00:00	2020-01-19 00:00	StartProcessing	Port of Rotterdam - 41543 - 2020-01-16	230	0	0	0	0	0	2020-01-14 15:36
Container0004		SHP - Shipper	7072785-Container0004 20200116	NOINFO	SHP - Shipper	2020-01-16 00:00	2020-01-16 00:00	StartProcessing	Port of Rotterdam - 41543 - 2020-01-16	0	110	0	0	0	0	2020-01-09 15:27
Container0003		SHP - Shipper	7072785-Container0003 20200116	NOINFO	SHP - Shipper	2020-01-16 00:00	2020-01-16 00:00	StartProcessing	Port of Rotterdam - 41543 - 2020-01-16	0	100	0	0	0	0	2020-01-09 15:25
Container0002		SHP - Shipper	7072785-Container0002 20200116	NOINFO	SHP - Shipper	2020-01-16 00:00	2020-01-16 00:00	StartProcessing	Port of Rotterdam - 41543 - 2020-01-16	0	100	0	0	0	0	2020-01-09 15:23
Container0001		SHP - Shipper	7072785-Container0001 20200116	NOINFO	SHP - Shipper	2020-01-16 00:00	2020-01-16 00:00	Planned	Port of Rotterdam - 41543 - 2020-01-16	0	40	0	0	0	0	2020-01-08 16:53

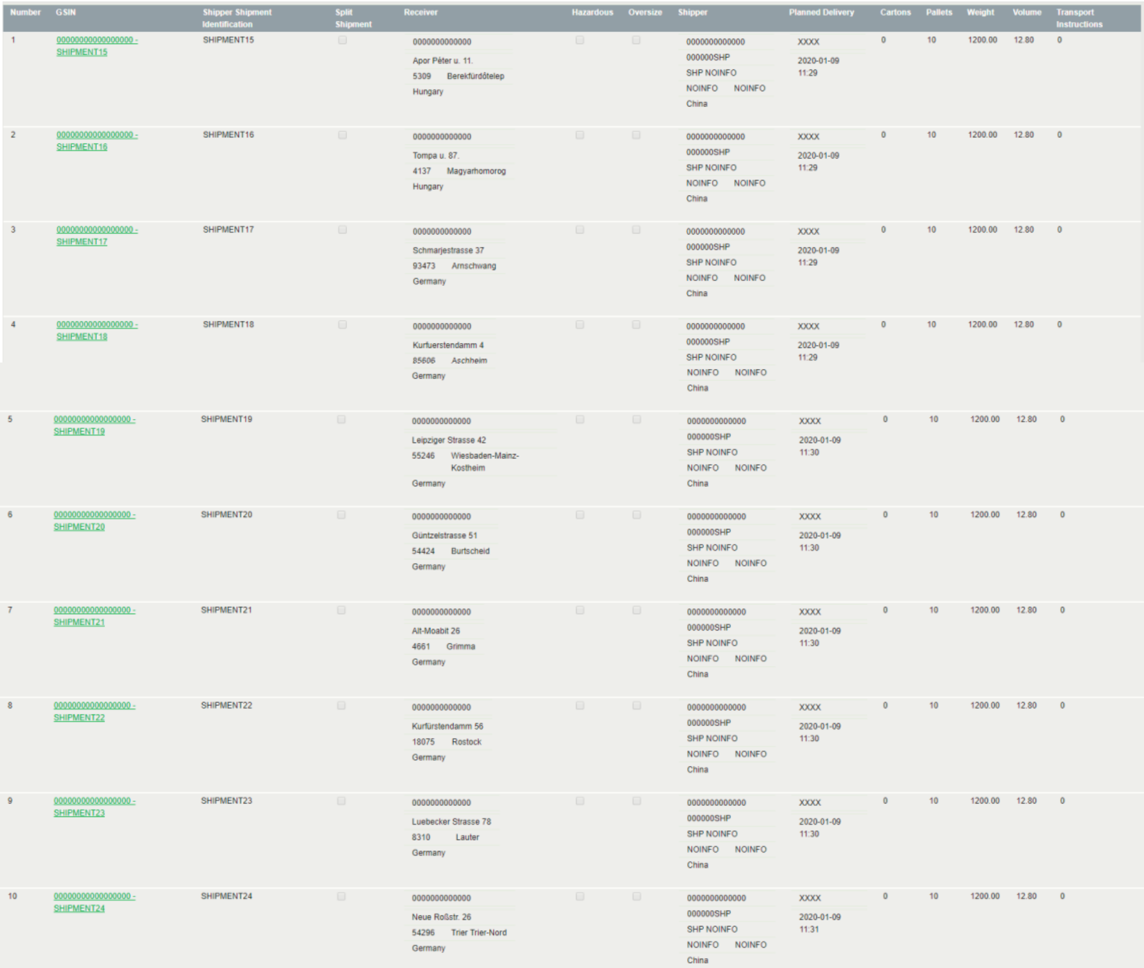
In this example, there are 5 containers that are arriving, of which one is already planned (Container0001). Container0005 contains 230 boxes (parcels) while the others contain pallets.

Looking closer at Container0003 (the middle line in figure 16), it contains 10 shipments; see figure 17.

Using the decision rules, these shipments need to be reconstructed, since they are to be discharged at all three ports.

Shipment ID	Country	Post Code	Inland Port
Shipment15	Hungary	5309	Basel
Shipment16	Hungary	4137	Basel
Shipment17	Germany	93473	Mannheim
Shipment18	Germany	85606	Mannheim
Shipment19	Germany	55246	Duisburg
Shipment20	Germany	54424	Duisburg
Shipment21	Germany	4661	Duisburg
Shipment22	Germany	18075	Duisburg
Shipment23	Germany	8310	Duisburg
Shipment24	Germany	54296	Duisburg

Figure 17: Shipments in Container0003

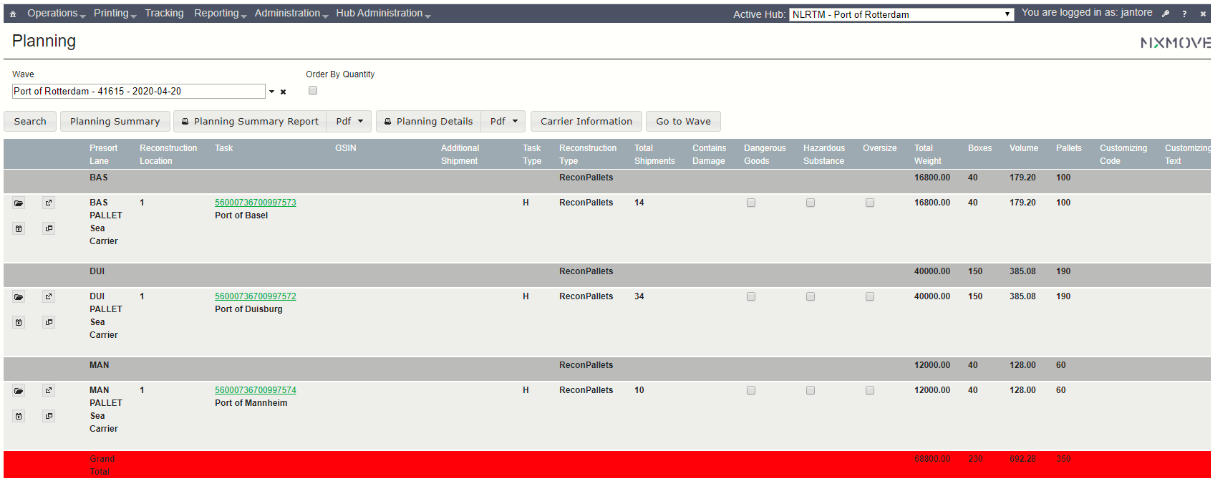


Number	GSIN	Shipper Shipment Identification	Split Shipment	Receiver	Hazardous	Oversize	Shipper	Planned Delivery	Cartons	Pallets	Weight	Volume	Transport Instructions
1	00000000000000000 - SHIPMENT15	SHIPMENT15		0000000000000 Apor Péter u. 11. 5309 Berekfürdőtelep Hungary			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:29	0	10	1200.00	12.80	0
2	00000000000000000 - SHIPMENT16	SHIPMENT16		0000000000000 Tompa u. 87. 4137 Magyarhomorog Hungary			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:29	0	10	1200.00	12.80	0
3	00000000000000000 - SHIPMENT17	SHIPMENT17		0000000000000 Schmarjestrasse 37 93473 Arnschwang Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:29	0	10	1200.00	12.80	0
4	00000000000000000 - SHIPMENT18	SHIPMENT18		0000000000000 Kurfuerstendamm 4 85606 Aschheim Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:29	0	10	1200.00	12.80	0
5	00000000000000000 - SHIPMENT19	SHIPMENT19		0000000000000 Leipziger Strasse 42 55246 Wiesbaden-Mainz-Kostheim Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:30	0	10	1200.00	12.80	0
6	00000000000000000 - SHIPMENT20	SHIPMENT20		0000000000000 Güntzelstrasse 51 54424 Burtscheid Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:30	0	10	1200.00	12.80	0
7	00000000000000000 - SHIPMENT21	SHIPMENT21		0000000000000 Alt-Moabit 26 4661 Grimma Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:30	0	10	1200.00	12.80	0
8	00000000000000000 - SHIPMENT22	SHIPMENT22		0000000000000 Kurfürstendamm 56 18075 Rostock Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:30	0	10	1200.00	12.80	0
9	00000000000000000 - SHIPMENT23	SHIPMENT23		0000000000000 Luebecker Strasse 78 8310 Lauter Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:30	0	10	1200.00	12.80	0
10	00000000000000000 - SHIPMENT24	SHIPMENT24		0000000000000 Neue Roßstr. 26 54296 Trier Trier-Nord Germany			0000000000000 000000SHP SHP NOINFO NOINFO NOINFO China	XXXX 2020-01-09 11:31	0	10	1200.00	12.80	0

We see that shipment 17 and 18 are should be discharged in Mannheim.

Once the planning is completed, the summary of the planning operations is shown in figure 18.

Figure 18: Planning completed



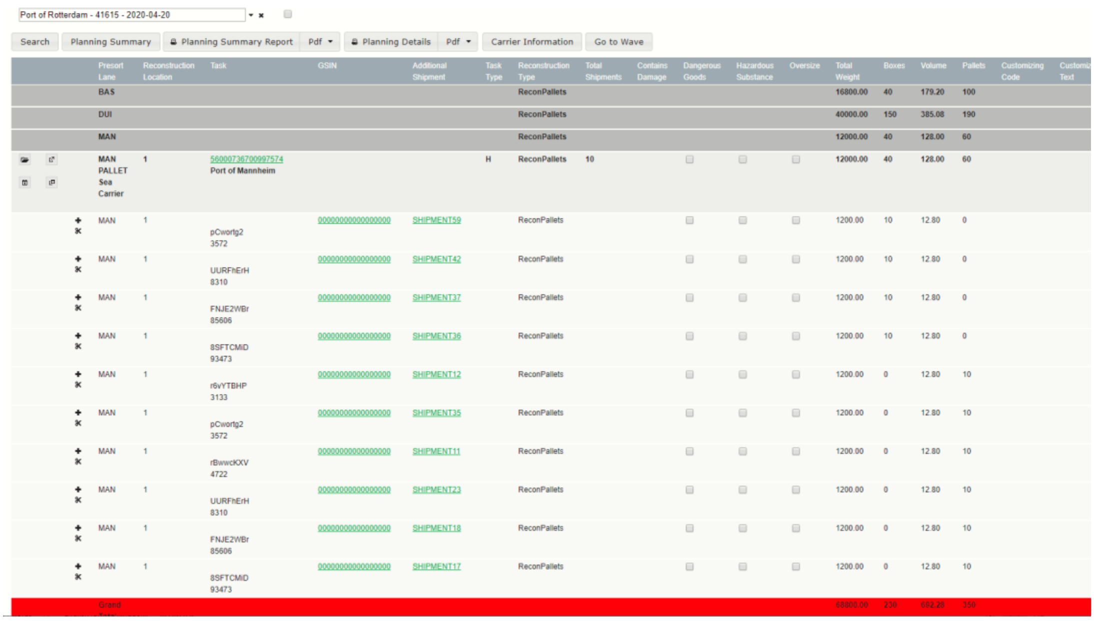
Presort Lane	Reconstruction Location	Task	GSIN	Additional Shipment	Task Type	Reconstruction Type	Total Shipments	Contains Damage	Dangerous Goods	Hazardous Substance	Oversize	Total Weight	Boxes	Volume	Pallets	Customizing Code	Customizing Text
BAS						ReconPallets						16800.00	40	179.20	100		
BAS PALLET Sea Carrier	1	56000736700997573 Port of Basel			H	ReconPallets	14					16800.00	40	179.20	100		
DUI						ReconPallets						40000.00	150	385.08	190		
DUI PALLET Sea Carrier	1	56000736700997572 Port of Duisburg			H	ReconPallets	34					40000.00	150	385.08	190		
MAN						ReconPallets						12000.00	40	128.00	60		
MAN PALLET Sea Carrier	1	56000736700997574 Port of Mannheim			H	ReconPallets	10					12000.00	40	128.00	60		
Grand Total												68800.00	230	692.28	350		

From the summary line at the bottom of the image, 230 boxes and 350 pallets have been planned. These numbers are also found in figure 16, which has information about the incoming cargo.

Detailing the information about the goods shipped to Mannheim, the information in figure 19.

Here we see that shipments 17 and 18 are included, as expected from the information in Figure 16

Figure 19: Detailing information about cargo to Mannheim



Port of Rotterdam - 41615 - 2020-04-20

Search | Planning Summary | Planning Summary Report | Pdf | Planning Details | Pdf | Carrier Information | Go to Wave

Presort Lane	Reconstruction Location	Task	GSIN	Additional Shipment	Task Type	Reconstruction Type	Total Shipments	Contains Damage	Dangerous Goods	Hazardous Substance	Oversize	Total Weight	Boxes	Volume	Pallets	Customizing Code	Customiz Text
BAS						ReconPallets						16800.00	40	179.20	100		
DUI						ReconPallets						40000.00	150	385.08	190		
MAN						ReconPallets						12000.00	40	128.00	60		
MAN PALLET Sea Carrier	1	56000736700997574 Port of Mannheim			H	ReconPallets	10					12000.00	40	128.00	60		
MAN	1	pCwortg2 3572	00000000000000000	SHIPMENT59		ReconPallets						1200.00	10	12.80	0		
MAN	1	UURFhErH 8310	00000000000000000	SHIPMENT42		ReconPallets						1200.00	10	12.80	0		
MAN	1	FNJE2WBr 85606	00000000000000000	SHIPMENT37		ReconPallets						1200.00	10	12.80	0		
MAN	1	8SFTCMiD 93473	00000000000000000	SHIPMENT36		ReconPallets						1200.00	10	12.80	0		
MAN	1	r6vYTBHP 3133	00000000000000000	SHIPMENT12		ReconPallets						1200.00	0	12.80	10		
MAN	1	pCwortg2 3572	00000000000000000	SHIPMENT35		ReconPallets						1200.00	0	12.80	10		
MAN	1	rBwwcKXV 4722	00000000000000000	SHIPMENT11		ReconPallets						1200.00	0	12.80	10		
MAN	1	UURFhErH 8310	00000000000000000	SHIPMENT23		ReconPallets						1200.00	0	12.80	10		
MAN	1	FNJE2WBr 85606	00000000000000000	SHIPMENT18		ReconPallets						1200.00	0	12.80	10		
MAN	1	8SFTCMiD 93473	00000000000000000	SHIPMENT17		ReconPallets						1200.00	0	12.80	10		
Grand Total												68800.00	230	692.28	350		

Reconstruction/Consolidation

Once the planning has been completed and the cargo arrives, the physical handling can commence. The handling may be manual or automatic, dependent upon the cargo volume. In figure 20 the terminal floor is prepared for manual handling of cargo. The illustration shows the lanes that have been identified during the planning process.

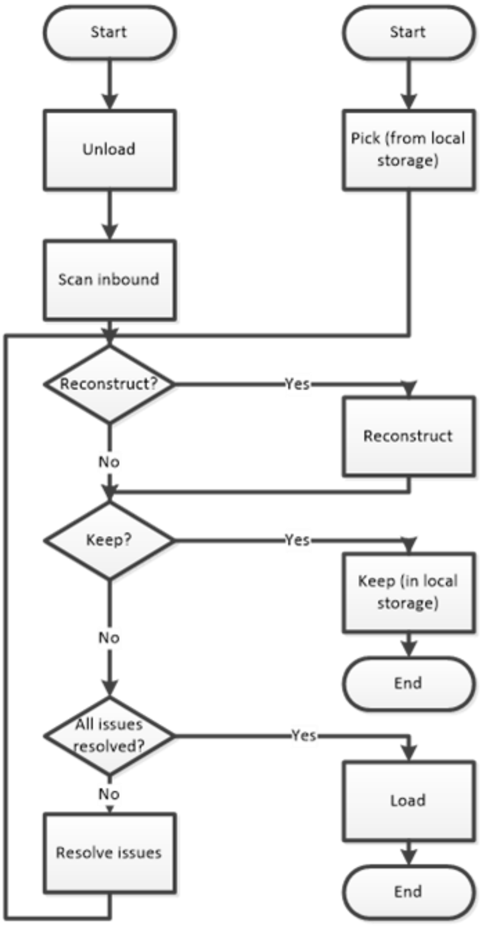
Figure 20: Preparing for manual handling of cargo

If cargo volumes are high, automatic sorting is possible, as illustrated in figure 21.

Figure 21 : Using a conveyor belt for sorting cargo

The flow diagram illustrating the handling process is shown in Figure 22.

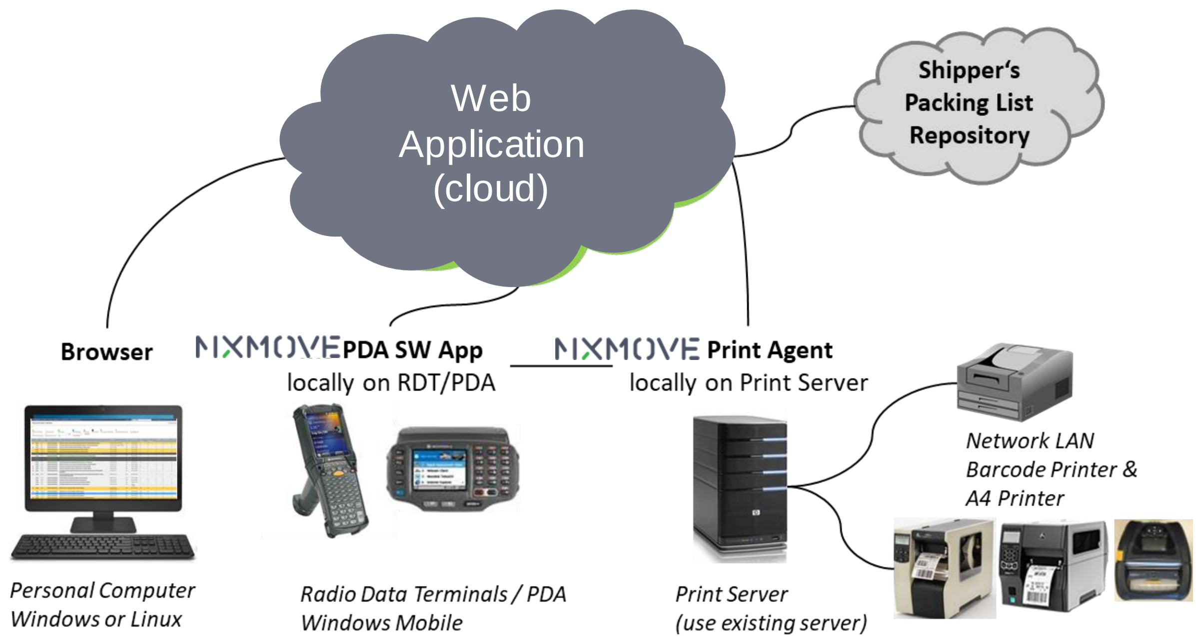
Figure 22: The reconstruction process



For the operation to work, the set-up in Figure 23 is required. It consists of:

- The web application. This is the solution in the "cloud", handling all functions and interacting with other information systems. The web application is the same for all hubs, but individual databases are established for each hub using the solution. The security is such that there is no interaction between the databases of the hubs.
- Each hub needs the following equipment to function:
  - A computer with a web browser
  - Hand-held terminals for scanning transport units and for giving instruction to operators
  - Capabilities to print labels and documents

Figure 23: Architecture

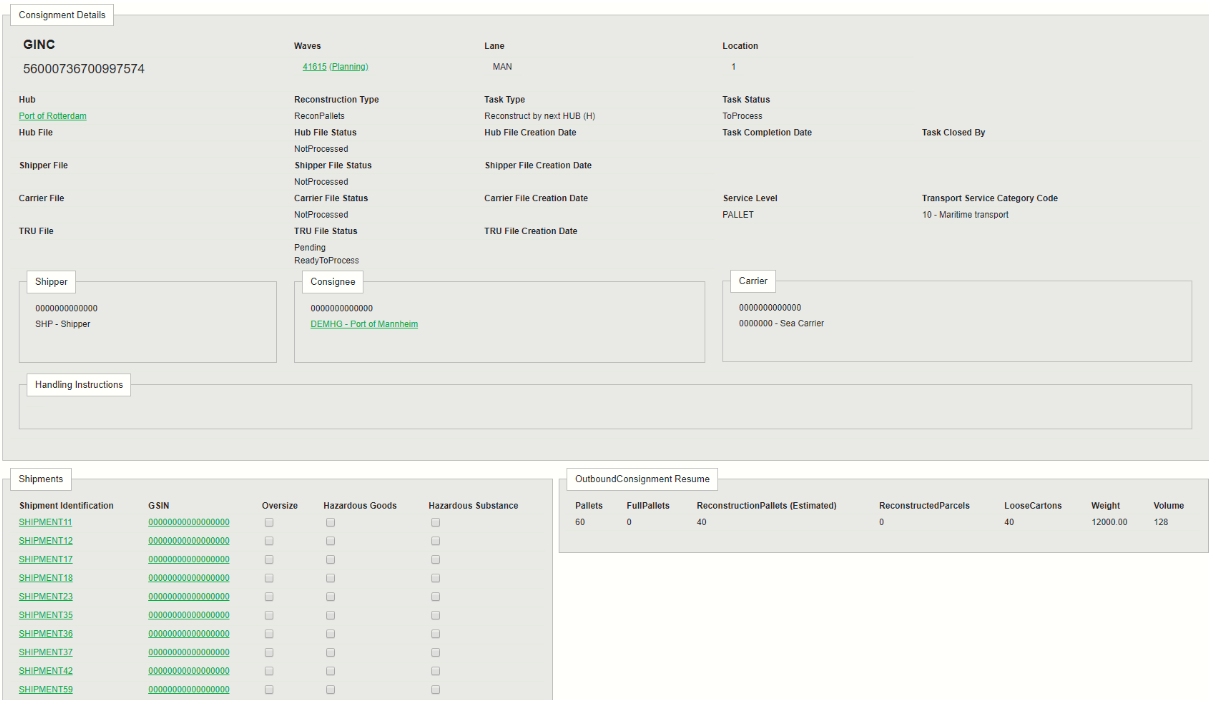


Since we do not actually perform the physical reconstruction/consolidation, there is no system information about this process.

Booking Space on Vessel

Once the booking is completed, space in vessels can be booked. Figure 24 shows the information to be used for generating the EDI message required by the vessel operator. The same information would be provided for booking if the vessel operator wanted MIXMOVE Match connected to the relevant management system using and API.

Figure 24: Input for booking to Mannheim



Port of Discharge

In the POD, the process of reconstructing/consolidating cargo is the same as in the Port of Loading. The key difference is that the decisions rules in the POL need to be more elaborate than those used in the POD, due to the more fine-grained information needed to properly utilise the transportation resources to be used for the rest of the hinterland transportation.

5.3.3.6 Vessel and Vessel Train

Operators

As described in Section **Error! Reference source not found.**, we distinguish between the role of:

- Vessel operator and
- Vessel Train operator.

It should be noted that in real operations, these roles may be performed by one organisation or by different organisations.

In this document we will only involving one organisation performing both roles.

In this example, the MIXMOVE Deliver solution will be used to illustrate operations of vessels and vessel trains.

Vessels

Presenting Availability

Again, it should be noted that this section assumes that vessel operations fall into the philosophy of the Vessel Train solutions, namely that all cargo in one vessel has the same discharge port.

Hence, vessel operators are providing information about vessel services from one port to another.

The vessel services will then be as follows:

- Rotterdam to Basel – lead vessel
- Rotterdam-Duisburg
- Rotterdam-Mannheim
- Duisburg-Mannheim

There will be daily departures from Rotterdam.

The following vessel schedules will be made available by the vessel operator(s) – daily departures:

Table 12: Input for booking to Mannheim

Port of Loading	Port of Discharge	Departure	Sailing time	Vessel type
Rotterdam	Basel	10:00	103:40	Class 4 – containers
Rotterdam	Duisburg	10:00	23:30	Class 5 – containers
Rotterdam	Mannheim	10:00	54:10	Class 4 – containers
Duisburg	Mannheim	09:30	30:40	Class 4 – containers

It should be noted that the table show an example. Since it is likely that sailing speeds, and therefore sailing times, will be dependent upon the characteristics of follower vessels, presentation of sailing schedules will be dynamic, based on observing the real operations. This means that sailing times and arrival and departure schedules will be kept dynamically updated.

Handling Booking of Containers

When receiving booking of space in vessel, the MIXMOVE Deliver will respond with confirmation or rejection, dependent upon availability.

Loading of Vessel

Once containers are loaded into vessels, the loading operations are recorded and loading lists are provided to the appropriate stakeholders.

Booking space in Vessel Train

Once a vessel is loaded, or in the process of being loaded, the vessel operator books space in a vessel train.

Vessel Trains

Presenting Schedules

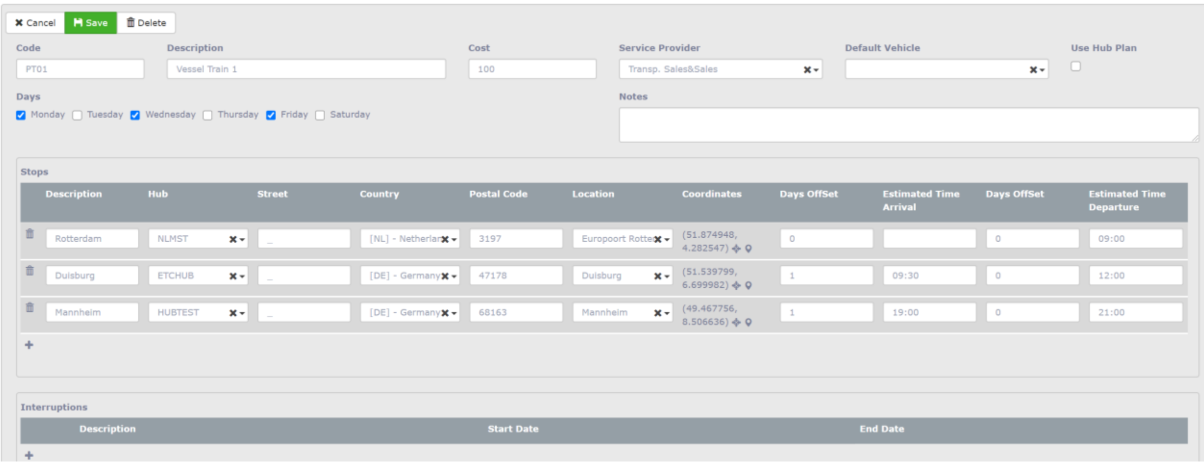
In the example, used in this document, Lead ships (also carrying cargo from Rotterdam to Basel), leave Rotterdam daily. The vessel train operator publishes schedules. An example is as follows:

Port	Arrival date	Arrival time	Departure date	Departure time
Rotterdam			07.07.2020	10:00
Duisburg	08.08.2020	09:30	08.08.2020	09:30
Mannheim	10.07.2020	16:10	10.07.2020	16:10
Basel	12.07.2020	17:40		

In this example, arrival times and departure times in Duisburg and Mannheim are the same. This is based on the assumption that new follower ships are able to join a vessel train without the Lead Vessel stopping and that the Vessel Train is continuously moving. Should this be unrealistic, the schedules will be adjusted accordingly.

MIXMOVE will allow to set the timescales for regular services, this mechanism may be used for defining the vessel train arrival and departures (see figure 25).

Figure 25: Input for booking to Mannheim



Each scheduled departure will have its own Id, this is instantiated automatically by the system allowing the booking to be placed against a specific trip using terms and conditions agreed for the schedule.

Handling Bookings

Bookings can be made in two ways, both supported by Mixmove:

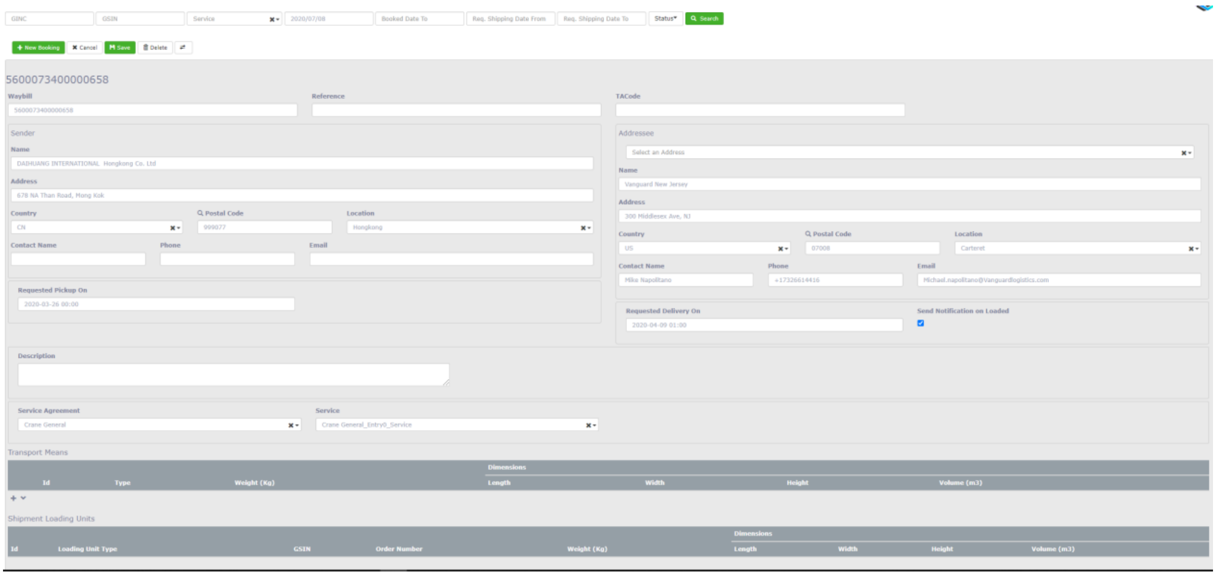
Contract booking: The relationship between the shipper and the company that delivers them is pre-agreed upon, so a new booking does not require approval or negotiation, since the contract details are already settled.

Spot booking: The spot booking is a booking placed on a one-time service request. The booking requires validation and confirmation, since the details, mostly addresses, contacts and rates to be applied still have to be agreed upon.

Booking may be placed in tree ways, via Backend, Customer Portal or thru EDI/Rest API.

Booking will be placed against a specific trip instance, the actual vessel assign will be calculated from the port of unloading.

Figure 26: Example of handling bookings



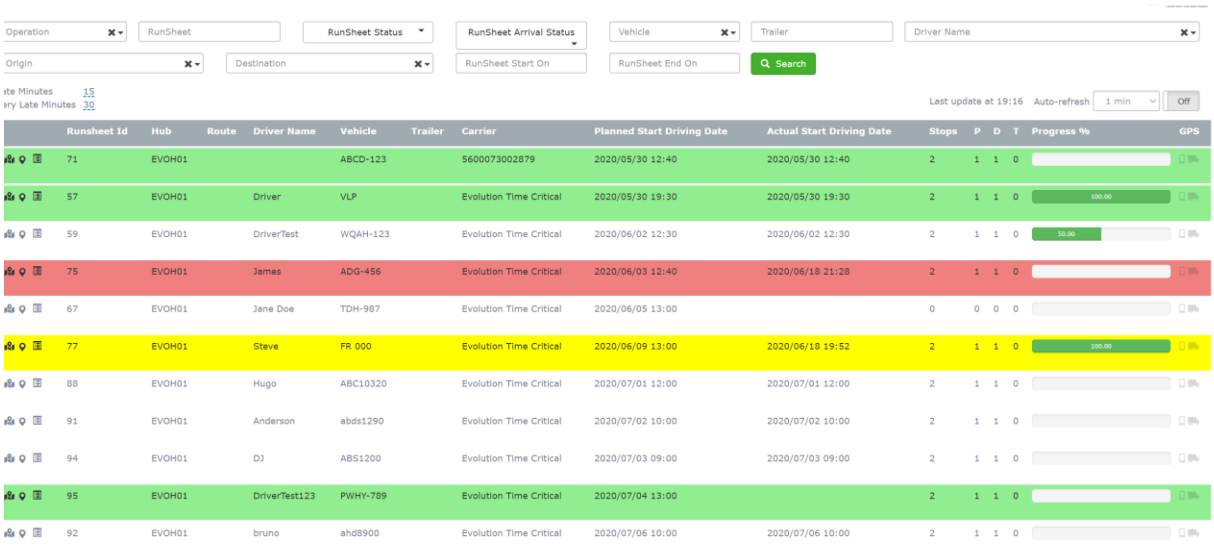
Reporting Progress

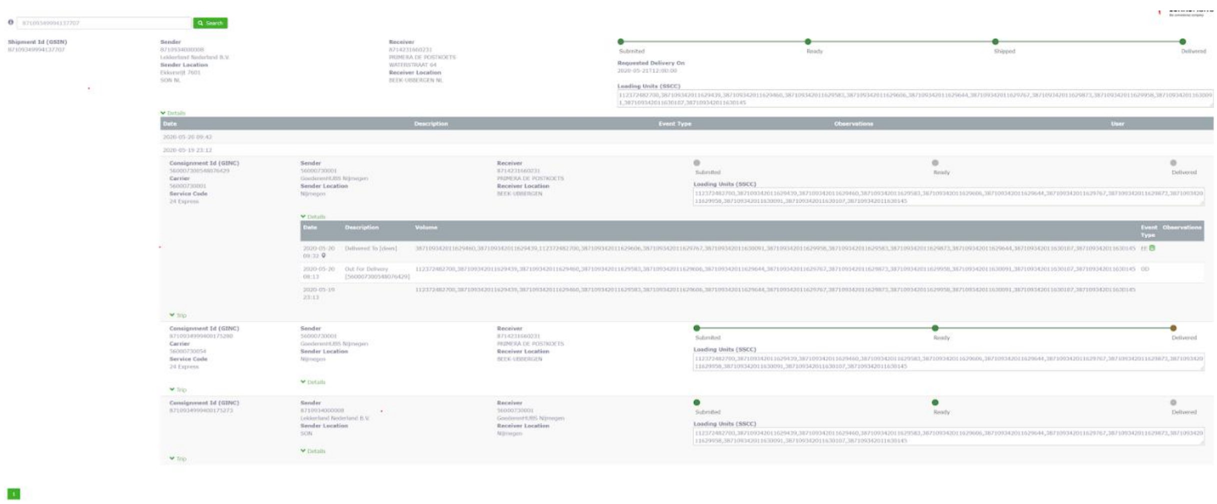
Tracking and tracing in MIXMOVE are enabled by the acquisition of event reflecting the progress of the transport execution. Multiple sources may be used:

- Port community systems (PCS) these are very often the aggregator of arrivals and departure confirmation on ports;
- Vessel location services, often exposed by aggregators pf both costal and port VTS systems
- IOT devices on containers or vessel

In any case MIXMOVE will provide ETA's and proactive notification on its deviation to all the relevant parties.

Figure 27: MMM screen shots





6 ANALYSIS OF RESULTS

6.1 Summary of results

This deliverable provides the main output of work done for task 2.3 in WP2 of the Novimar project. In this report the business models for the VT are developed along with the first developments of the cargo consolidation capabilities in ports.

A long list of 4 initial VT business models were developed. These initial business models were then further validated by IWT, short Sea and logistics experts. Based on these insights and expertise two initial business models are identified which will be further researched in the remainder of this project. These business models will also be included in the transport model as stated in D.2.2. Based on the developed business models also the operational issues and the initial VT variants are determined.

With respect to the cargo consolidation in ports, VT aims to improve transport operations and achieve maximum efficiency of the capacity of vessels via a cargo consolidation (or sorting) process. This process needs to take place in all loading ports, such that all cargo in one vessel has the same discharge port. The cargo consolidation capability of the VT is expected to bring the advantage that one single vessel does not need to call at all ports but different vessels can call at one single port or only at a few ports, thus the lead time is reduced and reliability of the service increases. Scenarios will be tested with and without cargo consolidation capability to estimate the expected savings in waiting time thanks to skipping certain calls. Specifically, four demonstration scenarios are proposed: a LV with cargo going from Rotterdam to Basel, a FV going from Rotterdam to Duisburg, a FV going from Rotterdam to Mannheim, and a FV going from Duisburg to Mannheim. It is assumed that cargo in the Port of Loading is a combination of intercontinental and SSS cargo going to the hinterland using VTs as the first mode of transport for this. The MMM software is adjusted so that it is possible to operate vessel trains.

6.2 Analysis of results

The outcome of this deliverable is the development of two possible business models of the VT. These business models will determined how the VT can create value for both the VT operators, the VT users (FV) and the cargo owners (ultimate users of the VT). These business models will also determine to a what the operational issues of the VT will be and what the initial VT variations will be which will be researched in the main “Antwerp case study”. These results match with the set objectives of this deliverable.

Next to that, also the cargo consolidation in sea ports needs to be developed. As described in D.2.2 this cargo consolidation could help to improve the effectiveness of the VT concept.

This result partly matches with the set objectives of this deliverable.

6.3 Corrective measures

The objectives of this derivable were partly met at the planned due date. Only task 2.3.5 needed further work and was added later to the deliverable.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The main output of task 2.3 in WP2 of the Novimar project in this report, is the development of the business models for the VT, along with the first developments of the cargo consolidation capabilities in ports. Four VT business models were developed and were further validated by IWT, short sea and logistics experts. This resulted in two initial business models, which will be further researched in future deliverables within this project. They will also be included in the transport model developed in D.2.2., which are:

- BM3: Liner (one shipping company owning all the fleet)
- BM4: Digital platform business model

These business model differ in a fundamental way. In the liner option there is only major player who is organizing the VT using its owns vessels, while in the digital platform model a more Uber type of business model is developed. In the latter, different vessel owners can join the VT. These different business models will also give different operational issues. And each of these business models will have different initial VT variants.

The terms of reference for cargo consolidation are determined for the port of loading, joining the vessel train and the vessel train operations, while no special capabilities are required to support activities in the port of discharge. Based on these terms of reference the full Marlo –IT tool can be developed. The working principle of the Marlo – IT tool can be implemented in the transport model (a reduction in waiting time for both vessels and cargo in deepsea ports).

In this deliverable one corrective measure was taken. This was the change in due date for the full development of the Marlo-IT tool. Changing this due date will not impact the work in this or other WPs. This is due to the fact that in the transport model the effect of the Marlo –IT tool will be taken into account (less waiting time for cargo that will be shipped with inland vessels). The way how is for the transport model, developed in D.2.2 and applied in D.2.4, less relevant.

7.2 Recommendations

With respect to this deliverable, there are no further recommendations, other than finalizing the work for task 2.3.5 before mid-2020.

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9 ANNEXES

9.1 Annex A: Public summary

This deliverable provides the main output of work done for task 2.3 in WP2 of the Novimar project. In this report the business models for the VT are developed along with the first developments of the cargo consolidation capabilities in ports.

A long list of 4 initial VT business models were developed. These initial business models were then further validated by IWT, short Sea and logistics experts. Based on these insights and expertise two initial business models are identified which will be further researched in the remainder of this project. These two business models will be included in the transport model developed in D.2.2. These two busies models are:

- BM3: Liner (one shipping company owning all the fleet)
- BM4: Digital platform business model

These business model differ in a fundamental way. In the liner option there is only major player who is organizing the VT using its owns vessels, while in the digital platform model a more Uber type of business model is developed. In the latter, different vessel owners can join the VT. These different business models will also give different operational issues. And each of these business models will have different initial VT variants.

Next to that, also the cargo consolidation in sea ports was developed. As described in D.2.2 this cargo consolidation could help to improve the effectiveness of the VT concept.

In this report the terms of reference for cargo consolidation are determined for the port of loading, joining the vessel train and the vessel train operations, while no special capabilities are required to support activities in the port of discharge. Based on these terms of reference the full Marlo –IT tool can be developed. The working principle of the Marlo – IT tool can be implemented in the transport model (a reduction in waiting time for both vessels and cargo in deepsea ports).

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9.2 Annex B: Initial business model development

Case Study 1[13]		
Business model		Liner
Role of LV		Dedicated[14] LV[15]
Stakeholders	1	VTO and LVO
	2	FVO
	3	CO
Role of Stakeholder	1	VTO owns the LV. VTO is a shipping company (which owns the LV). VTO owns the technology to coordinate the VT. VTO does matching between LVs & FVs and COs & LVs, FVs. VTO charges the FVs for the service provided (based on how long a FV stays in the VT & by knowing the operation costs of the LV and we divide with the number of the FVs plus the mark-up).
	2	FVO transports cargo from A to B. FV has the technology to be able to follow (technology installed in the FV). FVOs need to contact the VTO to become part of the VT (or vice versa: VTO sends requests for transportation to the FVOs & the FVOs will then reject or accept the request of the VTO). FVO receives booking of cargo and allocates cargo in the FVs.
	3	COs book cargo space in the FVs.
Responsibilities of Stakeholder	1	VTO builds & organises the VT. VTO provides the management of the VT: * keeping the VT safe * ensuring the departure & arrival times * communication responsibilities to FVs and operational environment (external parties). VTO sends out bill to FVOs.
	2	FV should be ready to depart (arrive at the VTs departure place) and be ready

[13] See the abbreviations list at the end of the document.
[14] Dedicated Leader Vessel (LV) is the vessel that does not carry cargo but only sails so as to control and guide the follower vessels (FVs).
[15] Why only dedicated LV & not a cargo LV is proposed for this business model (BM)? Because the cargo LV would delay the vessel train (VT) with its loading & unloading.

		to leave the VT. FVO manages cargo according to the request of CO.	
	3	CO should pay bill to FVO. CO provides service requirements to FVO on time.	
Value Proposition	1	VTO earns money by providing the VT organisation.	
	2	FVO: Lower operational costs[16]. FVO: Increase of operational/sailing time. (esp. for small ships)	
	3	CO: Lower transportation cost. CO: Less waiting time due to higher frequency of transport service. CO: Lower capital tie-up of cargo due to shorter transport duration (lower in-transit inventory cost and lower safety cost for the CO because lead time is shorter).	
Frequency of Departure	High		
Operating Sector/ Area	Medium to long distance (multi-stops[17]). Applicable for both SSS, IWT & Sea-river.		
Operational Issues	communications	FVO & LVO communication: * organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT). * navigational, e.g. communication with respect to the distance and speed with which the FVs should sail. LVO communicating to operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).	
	extra operational tasks required	Lock passage VTO does matching between LVs & FVs.	
Positive aspects of this case study		+ it keeps the operating procedure of the VO simple and closest to the way it is done currently. + competition between FVOs provides alternative services to COs (CO can choose between traditional waterborne transportation & the VT transportation or can choose among different VTs).	
Limitations of this case study		- There is economical risk for the LVO/VTO, if FVs do not match or if not sufficient FVs join the VT (insufficient demand).	

[16] Less crew members on board and more sailing hours.
[17] The number of stops could be reduced if bundling of cargo is applied.

	- VT capacity may not be sufficient for high demand peaks. - In case of a limited number of VTOs, there is a risk of an oligopoly. However, we need to point out that market as such will not be an oligopoly but sub-sections of the market might be. - If the VTO is a shipping company, there is risk that other shipping companies might be unwilling to cooperate with the competitor shipping company that will be the VTO.
Charging scheme between the VTO & the FVO	Cost plus markup.

Case Study 2		
Business model		Tramp
Role of LV		Cargo LV[1][2]
Stakeholders	1	VTO and LVO
	2	FVO
	3	CO
Role of Stakeholder	1	VTO owns the LV. VTO is a shipping company (which owns the LV). VTO owns the technology to coordinate the VT. VTO does matching between LVs & FVs and COs & LVs, FVs. VTO charges the FVs for the service provided.
	2	FVOs transport cargo from A to B & have the technology to be able to follow. FVOs receive booking of cargo and allocate cargo into FVs.

		FVOs need to contact the VTO to become part of the VT (or vice versa: VTO sends requests for transportation to the FVOs & the FVOs will then reject or accept the request of the VTO).
	3	COs book cargo space in the FVs via the VTO.
Responsibilities of Stakeholder	1	VTO builds & organises the VT. VTO provides the management of the VT: * keeping the VT safe * ensuring the departure & arrival times * communication responsibilities to FVOs and operational environment (external parties) VTO sends out bill to FVOs.
	2	FVOs should be ready to depart (arrive) and be ready to leave the VT. VOs manage cargo according to demand of CO.
	3	COs provide service requirements to FVO or LVO on time. CO should pay bill to FVO or LVO.
Frequency of Departure	Demand-based	
Operating Sector/ Area	Short to medium distances – dense part of the network. Applicable for both SSS, IWT and Sea-River.	
Operational Issues	communications	FVO & LVO communication:

		* organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT). * navigational, e.g. communication with respect to the distance and speed with which the FVs should sail. Also, to arrange the moments when the FV needs to enter or to exit the VT. LVO communicating with the “outside” operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).
	extra operational tasks required	Lock passage. VTO does matching between LVs & FVs and COs & LVs, FVs. Careful Purchasing decision for the FVs.
Positive aspects of this Case Study		+ The lump sum payment approach makes it more appealing to the VTOs, since they do not indirectly disclose their operating costs. Thus, profit margin might be higher for the VTO.
Limitations of this case Study		- The lump sum payment method makes the determination stage, in which the FVO evaluates if it is worthwhile to join the VT, a more critical element of the FVO’s tasks. Thus, it might demotivate the FVOs, if the lump sum is high. Therefore, we can see that the same element can be a positive aspect for one actor (being the VTO) & negative aspect for another actor (FVO if the lump sum is high). However, the main aim that this charging scheme is used is to facilitate the decision of the FVOs to join the VT. - In case of a limited number of VTOs, there is a risk of an oligopoly. However, we need to point out that market as such will not be an oligopoly but sub-sections of the market might be.
Value Proposition		
1		VTO earns money by providing the VT organisation.
2		VO: Lower operational costs.

	VO: Increase of operational/sailing time. (esp. for small ships)
3	CO: Lower transportation cost. CO: Less waiting time.
Charging scheme between the VTO & VO of the FV	Fix lump sum

Case Study 3		
Business model		Liner (one shipping company owning all the fleet)
Role of LV		Dedicated LV
Stakeholders	1a	VTO and LVO
	1b	FVO
	2	CO
Role of Stakeholder	1a	VTO owns the LV & the FVs (all the fleet).
		VTO is a shipping company that owns all the fleet.
		VTO manages the FVs.
		VTO owns the technology to coordinate the VT & also the technology that the FVs require so as to be able to follow.
		VTO is the same actor with VO in this case study.
		VTO does matching between VT & COs[18].
		VTO does not charge the FVs for the service provided in this case study because these costs are considered internal costs since all the vessels belong to the same shipping company.
		VTO/shipping company contacts the COs.
		VTOs/shipping company need to own the dedicated LV. (They can own or charter the FVs).
	1b	FVs transport cargo from A to B and have the technology to be able to follow.
		FVOs receive booking of cargo and allocate cargo into FVs.
	2	COs book cargo in the FVs via the VTO.

[18] In this case study, the matching is not between the LVs & the FVs because all the vessels belong to the same shipping company.

<table>
<tr><td rowspan="5">Responsibilities of Stakeholder</td><td>1a</td><td>To build & organise the VT & keep the VT safe (management of the VT). Ensuring the departure & arrival times. (communication responsibilities).</td></tr>
<tr><td rowspan="2">1b</td><td>To be ready to depart (arrive) and be ready to leave the VT.</td></tr>
<tr><td>To manage cargo according to demand of CO.</td></tr>
<tr><td rowspan="2">2</td><td>COs provide service requirements to VOs on time.</td></tr>
<tr><td>Pay bill to LVO/FVO (shipping company).</td></tr>
<tr><td>Frequency of Departure</td><td colspan="2">High</td></tr>
<tr><td rowspan="2">Operating Sector/ Area</td><td colspan="2">Medium to long distance (multiple stops)</td></tr>
<tr><td colspan="2">Applicable for both SSS, IWT & Sea-river.</td></tr>
<tr><td rowspan="7">Operational Issues</td><td rowspan="5">communications</td><td></td></tr>
<tr><td>FVO & LVO communication:</td></tr>
<tr><td>* organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT).</td></tr>
<tr><td>* navigational, e.g. communication with respect to the distance and speed with which the FVs should sail.</td></tr>
<tr><td>LVO communicating to operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).</td></tr>
<tr><td rowspan="2">extra operational tasks required</td><td>Lock passage</td></tr>
<tr><td>VTO does the matching with the COs (and the FVs which belong to the same shipping company).</td></tr>
<tr><td colspan="2">Positive aspects of this Case Study</td><td>+ Coordination of all vessels in the VT may be more effective, since more information is accessible to the VTO.</td></tr>
<tr><td colspan="2">Limitations of this case Study</td><td>- In case of a very limited number of full service VTOs, there is a high risk of an oligopoly or monopoly. However, we need to point out that market as such will not be an oligopoly but sub-sections of the market might be.</td></tr>
<tr><td colspan="2">Value Proposition</td><td></td></tr>
</table>

1a	VTO does not earn money as an independent actor as such by the FVOs, by providing the VT organisation, since the VTO is the shipping company that also owns the FVs (all the fleet). However, the VTO earns money (from the COs) for his/her shipping company for organising and operating the VT.
1b	VOs: Lower operational costs.
	VOs: Increase of operational time. (esp. for small ships)
2	CO: Lower transportation cost.
	CO: Less waiting time due to higher frequency of transport service.
	CO: Lower capital tie-up of cargo due to shorter transport duration (lower in-transit inventory cost and lower safety cost for the CO because lead time is shorter).
Charging scheme between the VTO & the FV	Everything belongs to/is operated by the same shipping company, thus there is no explicit markup. Thus, the costs that would be normally paid by the FVs to the VTO (if they would not belong in the same shipping company) are now considered as part of the operational costs. (internal costs allocation)

Case Study 4		
Business model		On demand platform
Role of LV		Cargo LV
Stakeholders	1	VTO
	2	LVO, FVO
	3	CO
Role of Stakeholder	1	VTO is a virtual service (app is also used).
		VTO has the legal responsibility of payments.
		VTO does not own any vessel, thus less capital is needed.
	2	VO transports cargo from A to B & has the technology to be able to lead (LV) and to follow (FVs).
		FVOs need to subscribe to the platform & be on time (same for the LVOs).
		LV can decline a FV.
	3	COs book cargo in the FVs via the app.
Responsibilities of Stakeholder	1	VTO is a virtual service.

		VTO builds & organises the VT.
		VTO provides the management of the VT:
		* keeping the VT safe
		* ensuring the departure & arrival times
		* communication responsibilities to FVs and the "outside" operational environment (external parties).
		VTO sends out bill to FVOs.
	2	VO should be ready to depart (arrive) and be ready to leave the VT & pay the submission fee to the platform.
		LVO/FVO manages cargo according to demand of CO.
	3	CO provides service requirements to VO on time.
		CO should pay the bill to the LVO/FVO & also should pay the submission fee to the platform.
Frequency of Departure	Demand based	
Operating Sector/ Area	High density network with a lot of movements.	
	Applicable for both SSS, IWT & Sea-river.	
Operational Issues	communications	FVO & LVO communication:
		* organisational/logistics (you can or cannot join the VT, due to existing limitations for the composition of the VT).
		* navigational, e.g. communication with respect to the distance and speed with which the FVs should sail.
		LVO communicating to operational environment (other ships, infrastructure manager because the VT will be part of the exiting traffic).
	extra operational tasks required	Lock passage.
		VTO/virtual service does matching between LVs & FVs & them with the COs.
		Careful Purchasing decision for the FVs.
Positive aspects of this Case Study		+ very modern and technologically based approach
		+ one stop shop for CO as with trucking
		+ cheaper VTO service
Limitations of this Case Study		- VTO may dominate markets notably through the control of the financial payment cascade (even beyond shipping also including the entire logistics service up to 4PL) and other stakeholders (as seen from UBER).
		- volatile demand-based booking is economically risky for the LVOs.

	- small additional investment costs for the platform.
	- hacking risk.
Value Proposition	
1	VTO is a virtual service, which might be cheaper because it is provided by a platform and thus it does not require labour.
2	VOs: Lower operational costs.
	VOs: Increase of operational time (esp. for small ships).
	VOs: Cheaper[19] VTO service for FVOs.
3	COs: Lower transportation cost.
	COs: Less waiting time.
	COs: Cheaper VTO service for the COs.
Charging scheme between the VTO & the FVO	Payments through the virtual service of the VTO based on a "lump-sum" base.

[19] A fee is not paid to the VTO since the VTO is a platform, but a subscription fee is paid for using the platform in order to recover the costs made of the platform investment & also of its maintenance. Thus this will result into a cheaper VTO service.

9.3 Annex C: Results of the interviews

Interview 1: Freight forwarder (Rail, Road, IWT)

Q1: BM4 of the 'on demand platform' seems the best for the following reasons: independent organizer could control the business, there might be profit sharing in the pool and much less capital investment is needed.

Q2: Score: BM1 (2), BM2 (3), BM3 (4), BM4 (1).

Q3: In BM3, Liner/one shipping company is the owner of all fleet is not applicable on the river Danube. Nowadays, there are also dominant shipping companies that do not allow other companies to fleshy pot. Therefore, this case is a simple shipping liner service on the river.

Q4: -

Q5: BM4 seems suitable for general and bulk cargo on the Danube.

Interview 2: Broker and barge owner (IWT)

Q1: BM4 is the best because the system will optimize all information received through the 'algorithm' used.

Q2: BM1 (2), BM2 (2), BM3 (4), BM4 (1).

Q3: sea-river transportation is very limited. Only 4-5 barges travel between Zeebrugge and Antwerp. They already use a platform for it but it is private. Thus, BM4 seems applicable also for the sea-river transportation. For SSS I do not have the knowledge so as to give answer. You need to contact the COs, so as them to tell you which BM they think that it is the best because at the end they decide how their cargo will be transported (via road, rail or water).

Q4: He recommended all BMS to be included under the BM4; thus to have a platform that will allow the composition of the VT based on the BM1, BM2 & BM3.

Q5: BMs are applicable for all cargo types and all regions (applicability everywhere).

(See Annex A for the detailed minutes of the interview)

Interview 3: Vessel Owner (IWT)

Q1: BM3 is the best to start with because it is the simplest and then apply BM4.

Q2: BM1 (4), BM2 (3), BM3 (1), BM4 (2).

Q3: VT is applicable for IWT, SSS and sea-river.

Q4: nothing to add or delete from the BMs.

Q5 (region): 1a) Duisburg to Rotterdam and 1b) Duisburg to Antwerp and maybe also consider applying the VT in the Albert Canal

Q5 (types of cargo): Not containers but 1) liquid cargo, 2) building materials, 3) agricultural products.

Interview 4: Logistics service provider and vessel owner (SSS)

Q1: BM3 and BM1 are the best to start with; BM4 seems the best but for a later stage, to be applied gradually because the market is probably not ready for the platform.

Q2: BM1 (1), BM2 (4), BM3 (1), BM4 (3).

Q3: IWT, SSS and sea-river seem applicable, but I would start with IWT barges.

Q4: I would look more at the CO, his perspective.

Q5: Start with containers/break bulk (for the VOs) and with contracts.

Interview 5: Vessel owner (IWT)

Q1: BM3 is the most applicable; being the owner of the whole VT, owning the whole fleet (for IWT). Otherwise there will be conflict of interests.

Q2: BM3 (1), BM2 (2), BM1 (3), BM4 (4).

Q3: All of them could be applied for IWT, SSS & sea-river.

Q4: Do not include multiple VOs/stakeholders. I am skeptical with cargo flows when having multiple stakeholders in one VT, it will be difficult to combine in one VT different COs & VOs; this might have an impact on lead time. Maybe it seems good theoretically, but it will not be easy in practice. Start small with one, two, three stakeholders. Start small and simple.

Q5: All cargo types could be transported but to start with containerized cargo.

Interview 6: Vessel owner (IWT)

Q1: BM3 (Liner, full owner) is the best for IWT because the VTO is mastering all elements of the VT.

Q2: BM3 (1), BM1 (2), BM2 (3), BM4 (4).

Q3: BM1 and BM3: the best is IWT, then Sea-River; BM2: IWT, SSS and Sea-River; BM4: the best is SSS, Sea-River, then IWT.

Q4: We need to add for each BM the responsibility of the VT, and the insurance that will cover the cargo and the vessels.

Q5 (BMs allocated to a market): The system of motor vessel is mostly adapted to regular transports, as shuttle, in this case BM1 and BM3 are better for the VT concept.

Q5 (region): the Main Channel has specific rules and Vt is not applicable in Danube due to the low freight rates and crew's fees.

Interview 7: Vessel owner

Q1: BM3 is the best because the coordination of all vessels should be in the hands of the VT. Also the LV should definitely be cargo less.

Q2: BM3 (1), BM1 (2), BM2 (3), BM4 (4)

Q3: No response

Q4: No response

Q5 : No response

Interview 8: Broker (IWT)

Q1: BM3 is the best. The VT seems technically and operationally feasible, if all processes are controlled by one operator.

Q2: BM3 (1) and BM1, BM2, BM4 (4).

Q3: Yes, all four BMs seem equally applicable to IWT, SSS and sea-river, but especially IWT should start with BM3 to minimize the risk.

Q4: BM 4 should focus on a dating platform between shipper and IWT service provider.

Q5: All cargo types could be transported.

Interview 9: Intermodal logistics service provider & barge operator (IWT, rail, road)

Q1: BM3 and BM4 are the best because the management and responsibility is focused in one company.

Q2: BM3 and BM4 (1), BM1 (3), BM2 (4).

Q3: Yes, all four BMs seem equally applicable to IWT, SSS and sea-river.

Q4: The option is of interest where a VT serves a sea port but each of the FVs focuses on a small number of terminals. The usage of flat bottom but wider vessels as a type of FVs may be of interest for certain markets in case of low water periods.

Q5: In principal, the BM could be that a LV can operate to a region (Lower Rhine, Lower Upper Rhine, Higher Upper Rhine), where each FV serves different terminals.

Interview 10: IWT operator, vessel owner and vessel sales & leasing (IWT)

Q1: BM3 is the best because the management and responsibility is focused in one company.

Q2: BM3 (1), BM1 as well as BM2 (2) and BM4 (3).

Q3: Yes, all four BMs seem equally applicable to IWT, SSS and sea-river.

Q4: Fleet management and vessel operations may be provided by different stakeholders to minimize risks.

Q5: No specific cargo. No specific region but waterways with no or big locks might be preferable.

Interview 11: Waterway authority

Q1: BM3 is the best model as a central governing body may seek synergies and dispatch the units optimally.

Q2: BM3 (1), BM1 (2), BM4 and BM2 (3 each).

Q3: No, because the number of vessel units and liner service offerings varies in IWT and SSS and does not exhibit sufficient scope for a sustainable BM.

Q4: The leading role of the LVO is crucial, the FVs are to benefit from the experience and ideal path provided by the LVO. The entry fee, on the contrary, may work as a show-stopper as it can lead to increased reluctance to adopt the service.

Q5: The Rhine, the North and West German waterways and the Benelux waterways are more promising activity areas compared to the Danube. (No statement with respect to the cargo type).

Interview 12: Intermodal logistics service provider

Q1: BM4 is the most promising BM as it relies on an efficient digital mechanism to match supply and demand.

Q2: BM4 (1), BM1 (2), BM2 (3), and BM3 (4).

Q3: No, as the entire VT concept appears to be of limited applicability in SSS because the lower frequency of services and the heterogeneity of origin-destination relations lead to smaller parts of joint voyage and, hence, does not permit the building and operation of VTs.

Q4: Staff pooling might substantially help the BM4 and BM1 to become even more attractive and economically viable.

Q5: With respect to the cargo type, there is no special preference detectable. As to the geographic coverage, areas with lots of locks and bridges as well as areas with crossing traffic, like the one of ferries crossing the Rhine, may not be the best application areas.

Interview 13: IWT interest group

Q1: BM4 is the most interesting BM because a marketplace helps matching supply and demand for LVs ready to create a VT.

Q2: BM4 (1), BM2 (2), BM3 (3), and BM1 (4)

Q3: No, hinterland supply from the large seaports of Belgium and the Netherlands (and Germany, possibly) appears more promising than point-to-point transport relations. In the first place, this is related to IWT. However, SSS could exhibit similar supply schedules with many delivery stops along a lengthy coast (e.g., in Scandinavia), which again lets VTs appear as an interesting approach.

Q4: The main benefit of joining a VT is the experience and ideal path provided by the LVO to the FVs. However, this is not necessarily confined to VTs but can also be offered by dedicated navigation assistance systems, especially in times of artificial intelligence and machine learning. A loose coupling in the form of convoys might, thus, be more applicable. This could be a modern version of the old towing units, requiring considerably less energy for a high transport capacity. In addition, the patent obligation might be omittable, so that there is no need of additional pilots on board of such vessels.

Q5: Liquid bulk appears to be most promising as the tank vessels generally contain large volumes of one type (or a few types) of cargo. Other than that, the cargo type is not decisive as the convoy principle is generally applicable to all of them. With respect to the geographical coverage, the main application area for vessel platooning will be between Duisburg and Rotterdam or Antwerp, respectively.

9.4 Annex D: Planning and Execution for cargo consolidation

9.4.1 Planning

9.4.1.1 Port of Loading

Prior to the cargo arriving at any vessel train port of loading, the information system managing the NOVIMAR port terminal activities (MixMoveMatch) need information about the arriving cargo. This information is then used to plan the activities that need to take place in order to prepare vessels for joining a vessel train.

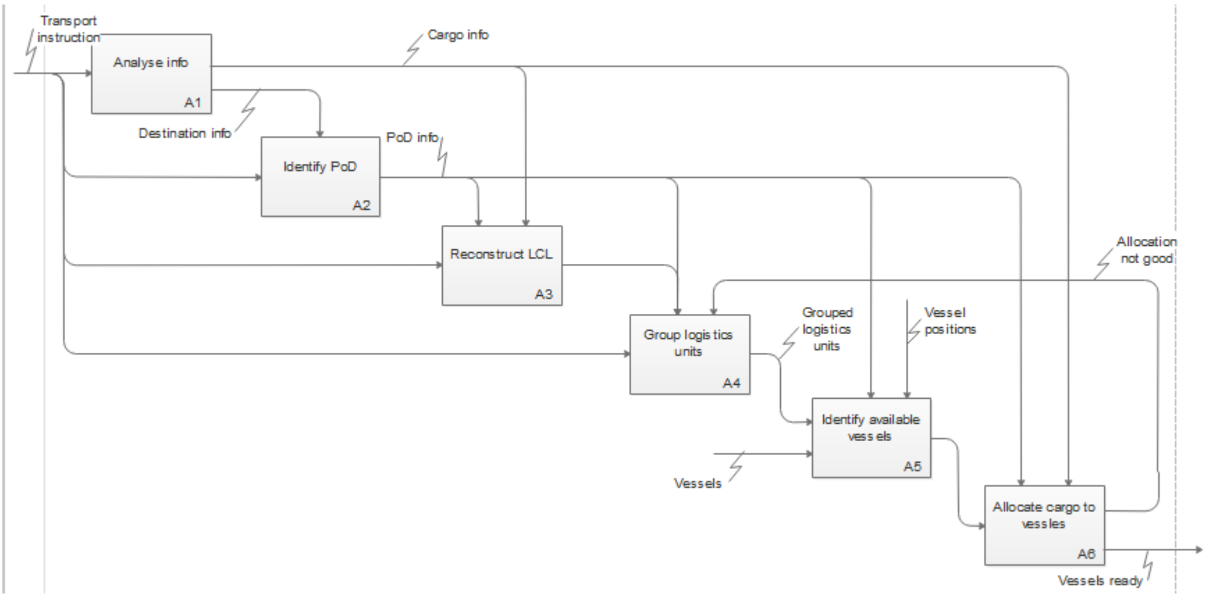
The key task here is to ensure that all cargo to be loaded onto a vessel has the same discharge port.

We have two scenarios:

- Full containers (or logistics units) or containers (or logistics units) that are sealed (FCL).
- Less than full container loads (LCL) and unsealed loading units (containers, rail wagons) that need to be stripped and cargo reconstructed.

The activities in figure D.1 describes the process for planning the processes in the Port of Loading, such that vessels are prepared for joining vessel trains.

Figure D.1: Planning activities in Port of Loading



It is assumed that information about the cargo to be received is provided in the GS1 Transport Instruction format. Any other message containing the same information may be used.

- A1. In this activity information about all incoming cargo in the next few hours (the time period may be chosen by the user of the system) is collected and analysed. Information useful in the remaining planning activities are extracted and made available to the other activities.

- A2. Here information about the destination of the incoming cargo is used to identify the most appropriate Port of Discharge (PoD). If the incoming cargo is FCL and the container is sealed, then the container will not be touched in Port of Loading. If an LCL load has cargo having the same destination or destinations that are close, these will be passed through the Port of Loading unchanged.

  Cargo that are arriving as LCL and other cargo that need to be reconstructed need to be handled at the Port of Loading to ensure that the containers or other loading unit used in the vessel train are properly utilised. Destination information for this cargo is also used as input in the next activity.

  Decisions about PoD will also be influenced by weather and other environmental conditions. In the case rivers are difficult to navigate, vessel trains will be used as much as possible, anr other transport means will be used to ensure reliable delivery of cargo.
- A3. Reconstructing LCL means that the destination information of the LCL cargo is used to determine the best possible Port of Discharge. All LCL cargo having the same PoD will be assigned to the same container. Once all assignments have been made, the use of containers will be validated. If containers have much empty space, then a new analysis of which PoD to be used will be made, and the reconstruction repeated. This iterative process will continue until we have the best possible use of resources.
- A4. The result of the previous activities is that we now have FCL with PoD identified. The grouping is keeping together all those loading units together that has the same PoD. These are to be assigned to the same vessel or vessels. In the case where it is not possible to group cargo in a way that enables proper use of the available vessels, cargo may be stored at the PoD until sufficient cargo is available for utilising the vessels.
- A5. Now that we have all cargo as FCL and grouped based on PoD, we need to identify the vessels that are available to move the goods. The sources for this information need to be identified. One solution is that all vessels that wish to be used in vessel trains report their position at all times to the vessel train management system
- A6. Once we have cargo and vessels available, we can assign cargo to the vessels. We will here try to achieve the best possible utilisation of vessels. This will also be an iterative process, which will continue until the best possible utilisation has been achieved.

After concluding these activities, the physical handling of cargo may commence.

9.4.1.2 To Join Vessel a Train

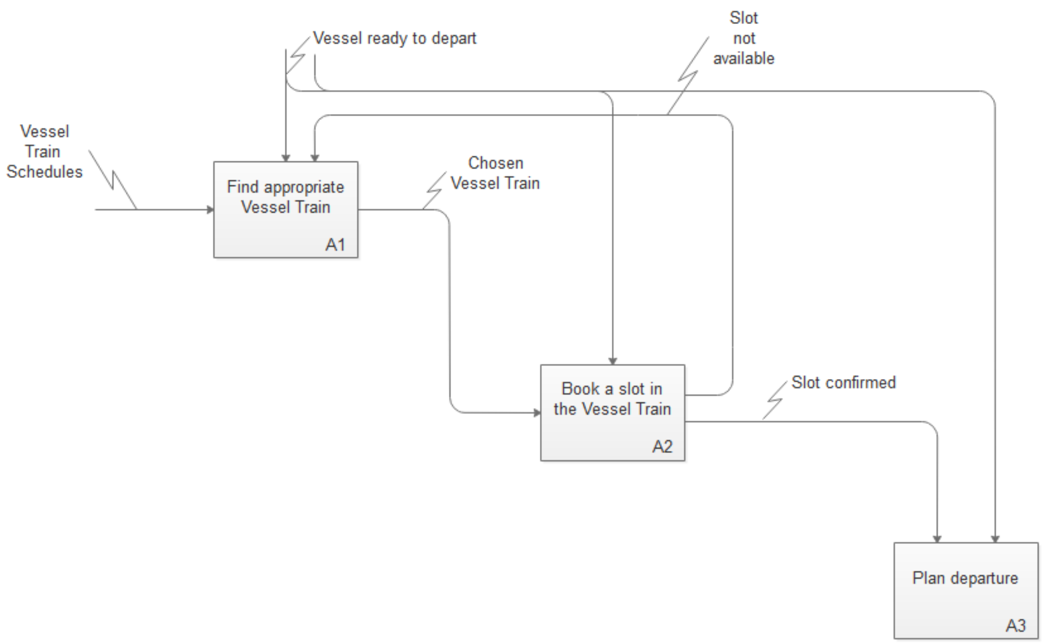
Regularity and reliability are also requirements that need to be taken into account when establishing the vessel train services.

In practice, this means that the Lead Vessels need to operate similar to so-called liner services. Consequently, Lead vessels have predefined start and end ports and regular schedules between these. The services to be provided by Lead Vessels need to be investigated in the NOVIMAR project.

The schedules of the Lead Vessels need to be published so that all those preparing Follower Vessels have access to them.

Figure D.2 Describes the process of booking a slot in the appropriate Vessel Train.

Figure D.2: Planning to join a Vessel Train



- A1. Once the planning of the vessel is complete, it is time to find the appropriate Vessel Train to join. Lead Vessels have predefined routes and related schedules. The first task in planning is to find the Vessel Train with the right route and then find the appropriate schedule.
- A2. Once the Vessel Train has been identified a booking is sent from the Pod of Loading management system to the Vessel Train management system. If the booking is confirmed, then all is well. The booking may be rejected because the Vessel Train is unable to have more vessels joining. In that case, the search for an appropriate vessel train will be repeated.
- A3. When the vessel has obtained a slot in a Vessel Train, the departure is planned in detail.

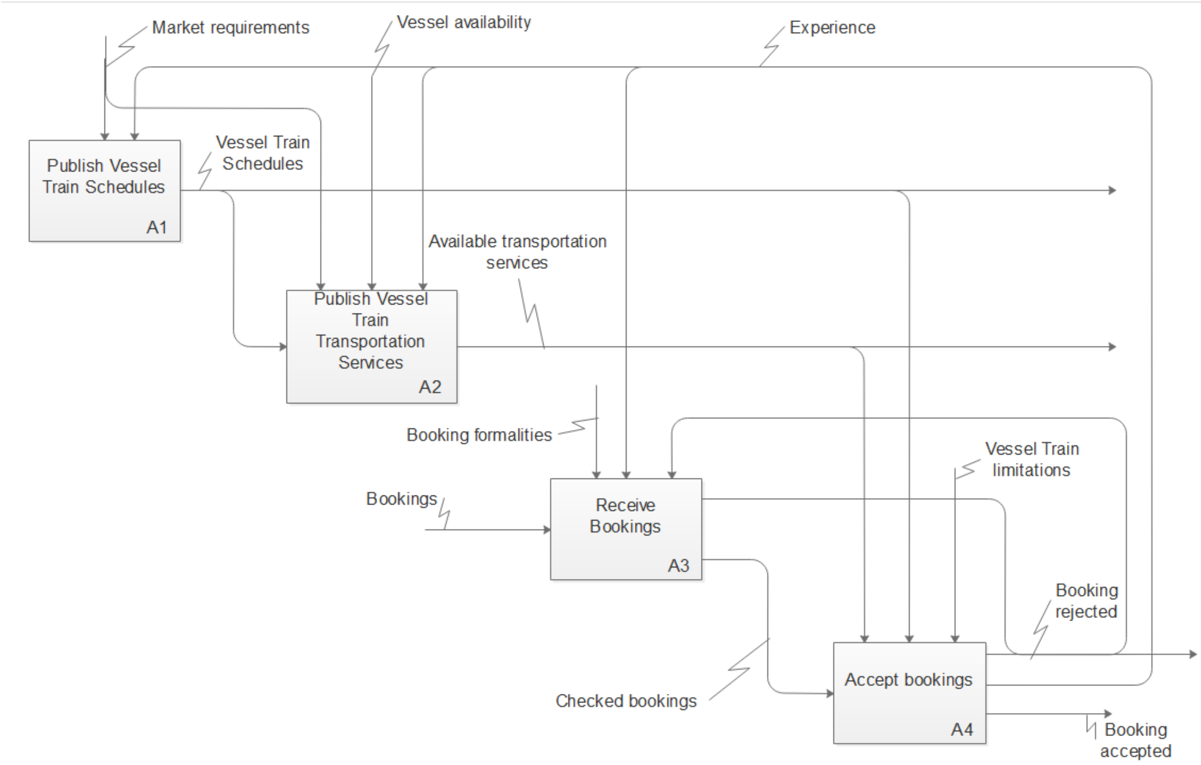
9.4.1.3 Planning Vessel Trains

As stated previously, Vessel Trains need to have well defined routes and schedules. The Vessel Train management system need to be able to publish these routes and services to those wanting to have vessels joining the Vessel Trains.

However, the Vessel Train management system needs to be able not only to publish to those operating vessels, but it needs to include a catalogue of all the logistics services that may be provided by the vessel train, from a logistics point of view. It is important that those planning door-to-door logistics operations know, at all times, the availability of transportation services.

Figure D.3 contains key functions that need to be provided by the Vessel Train management system during the planning process.

Figure D.3: Planning/composing vessel trains



- A1. The Vessel Train operations will be liner services. The routes will have to be determined, and schedules need to have high frequencies in order to support availability. This function will publish the Vessel Train schedules to all relevant stakeholders. The Transport Services Description (TSD) format in ISO/IEC 19845 should be used to publish these.
- A2. Once the routes and schedules of the Lead Vessels and knowledge about available follower vessels, a catalogue of the logistics services offered by Vessel trains and Follower vessels should be prepared and made available to stakeholders. The TSD format should be considered here as well.
- A3. Bookings for slots in Vessel Trains is received from those dealing with follower vessels. They are checked for formal issues (the combination of Vessel Train route and schedule and the specified PoL and PoD is possible) and forwarded.
- A4. A booking requests that a follower vessel is to join a specific Vessel Train. This function needs to analyse the composition of Vessel Trains from the PoL on and until the PoD. If the adding the follower vessel does not violate any of the limitations of this specific Vessel Train (total limit of follower vessels allowed, size of follower vessel vs fairway requirements, etc.) the booking will be confirmed. If not, it will be rejected.

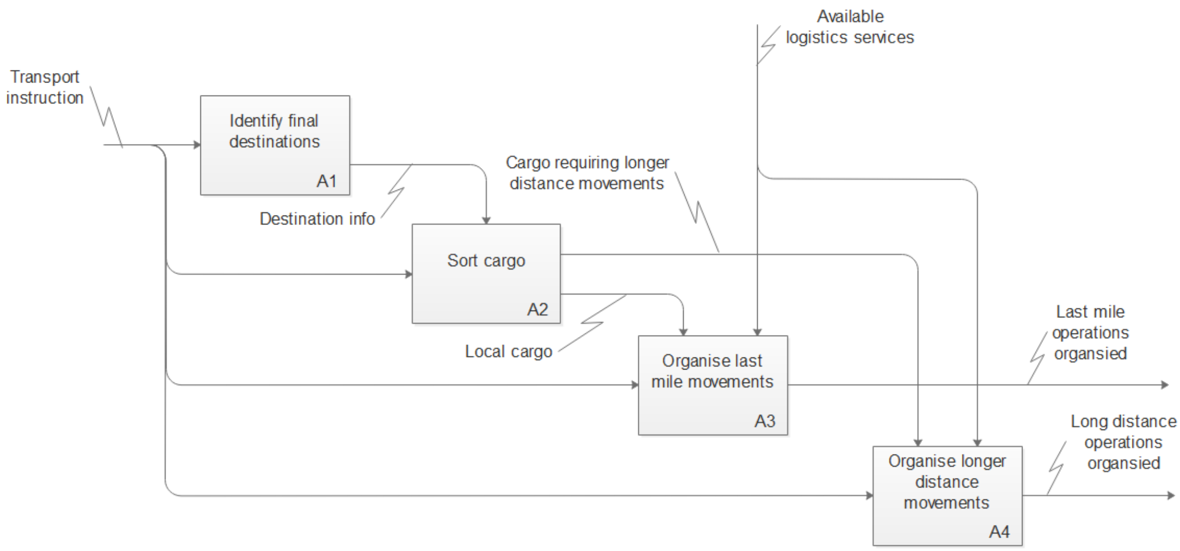
9.4.1.4 Port of Discharge

At the Port of Discharge the process is similar to that of the Port of Loading. However, now the actual destinations need to be taken into account when planning. There are two scenarios possible:

- The end destination is close, so that effectively a "last mile" operation needs to be planned.
- The end destination is further away such that a combination of transport modes may be the best option.

The planning activities in Figure D.4 will take place in the PoD.

Figure D.4: Planning at the Port of Discharge



The functions in the Port of Discharge can be performed using the existing version of the MixMoveMatch software. He functions are:

- A1. Identify all the final destinations of the follower vessel that is about to arrive.
- A2..Cargo is sorted on the basis of final destinations and information provided to the appropriate transport organising function.
- A3. In organising the movement of local cargo, it will be investigated whether cargo need to be reconstructed or not. Cargo that may be moved without reconstruction will do so. Cargo that need to be reconstructed is planned for reconstruction. Cargo that need to wait until transportation resources may be properly utilised is kept in temporary storage. Transport services to move cargo will be identified and booked. It is envisioned that only one mode of transport will be used in "Lat Mile" operations, but it may also be the case that larger vehicles are used to move goods in containers to locations where individual parcels will be picked up by agents using bicycles or other smaller vehicles.
- A4. In organising the movement of local cargo, it will be investigated whether cargo need to be reconstructed or not. Cargo that may be moved without reconstruction will do so. Cargo

that need to be reconstructed is planned for reconstruction. Cargo that need to wait until transportation resources may be properly utilised is kept in temporary storage. Transport services to move cargo will be identified and booked. Transport services may be direct, or a combination of modes may be used until cargo reaches the distribution centre closest to the final address, where “Last Mile” operations will be organised.

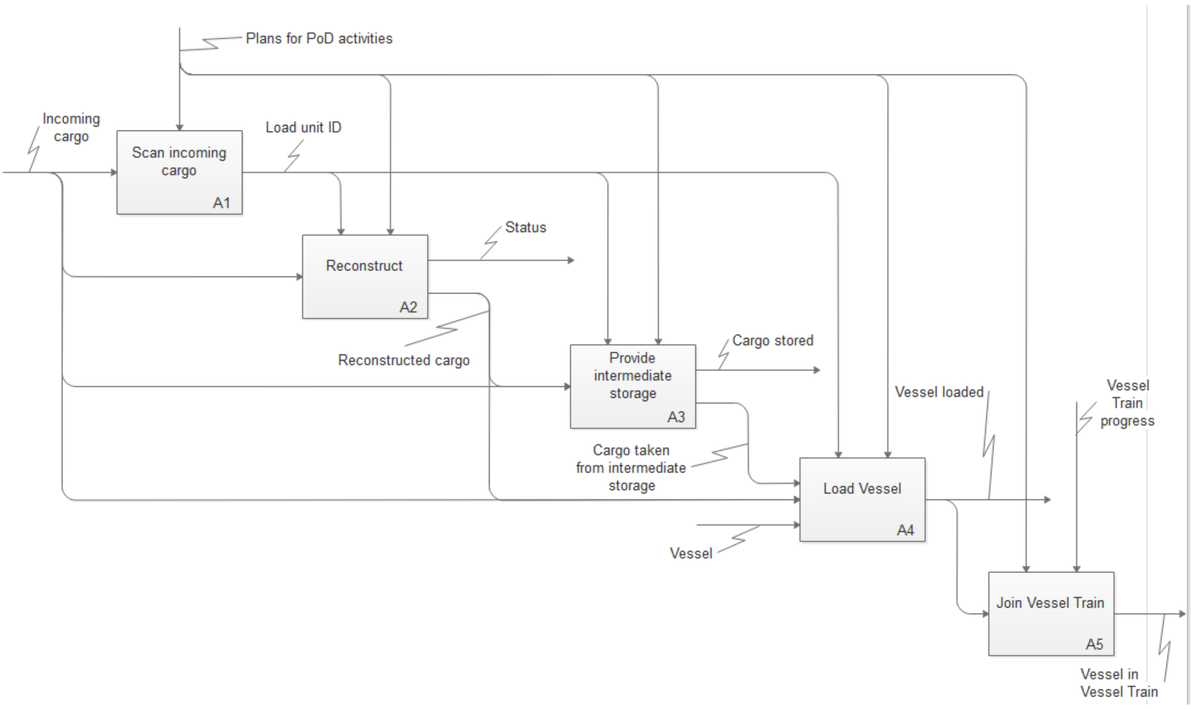
9.4.2 Execution

Execution in this context means handling cargo at the Port of Loaning and the Post of Discharge, recording that a follower vessel has joined a Vessel train and monitoring the movement of the Vessel Trains, including the movement of a follower vessel from the Vessel Train to the berth at the Port of Discharge.

9.4.2.1 Port of Loading

During execution, the following activities will take place at the Port of Loading (see figure D.5).

Figure D.5: Execution at Port of Loading



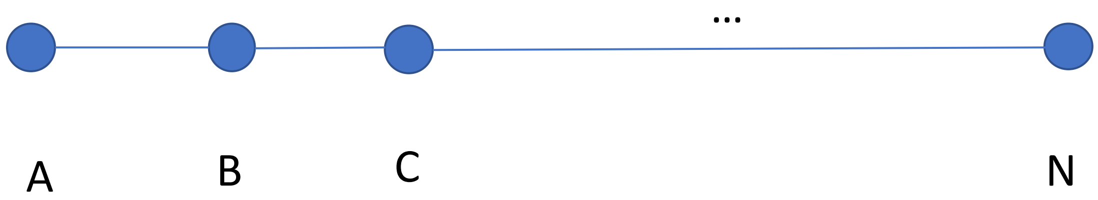
- A1.All loading units need to have a unique ID. In current implementation MixMoveMatch uses the GS1 SSCC standard for identifying logistics units, but any standard is possible. On arrival in the PoD, all loading units are scanned, and they are handled according to the plan that was prepared previously.
- A2. All cargo that has been identified for reconstruction is taken aside, and the reconstruction takes place. A status report is provided to the overall logistics management system.

- A3. If cargo needs to be kept for some time due to the lack of availability of vessels or a situation where there is not enough cargo to utilise a vessel properly, the cargo is kept at the PoL until the situation is resolved.
- A4. Cargo that is reconstructed, cargo that passes through the PoL unchanged and relevant cargo from intermediate storage is loaded onto the vessel, according to approved plans.
- A5. Once the vessel is loaded, and the lead ship is in the right position, the relevant follower vessel will leave the berth and join the vessel train.

9.4.2.2 Vessel Train Movement

As stated before, the Vessel Trains will operate based on fixed routes and schedules. A route comprises a number of ports, as indicated in Figure D.6.

Figure D.6: Vessel Train Route



The lead vessel starts at the beginning of the route (marked as Port A in Figure D.6) and passes by the other ports on the route (Port B, Port C, etc.) until the end port, (here marked as Port N).

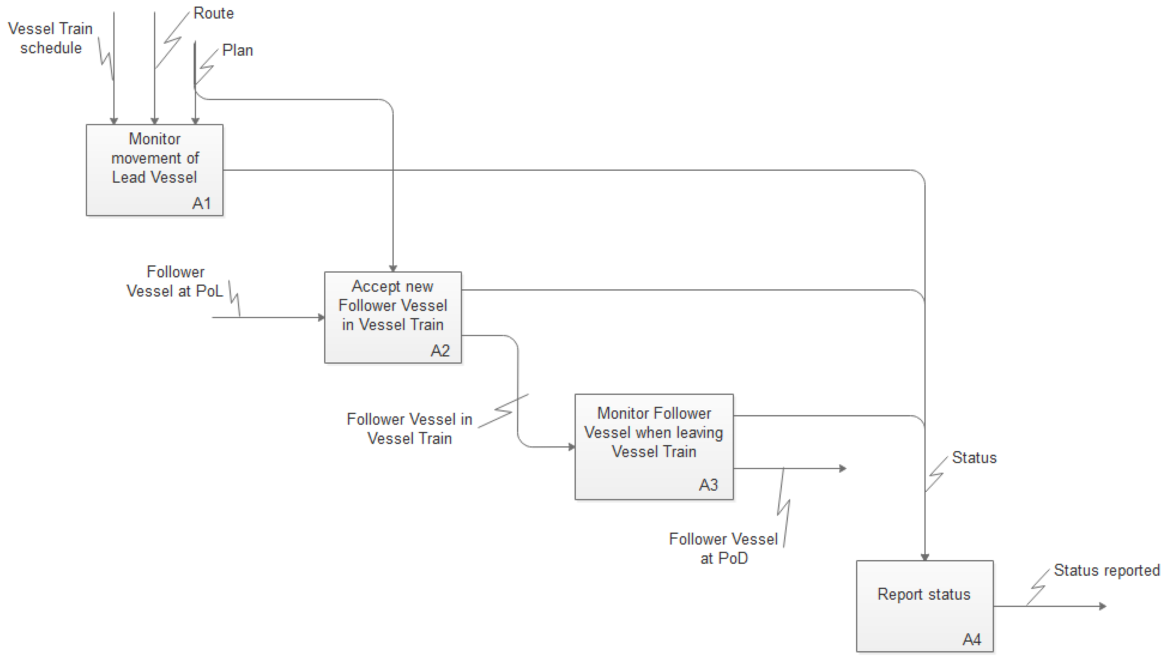
As the Vessel Train passes each port, follower vessels may board and/or leave the Vessel Train. If the Lead Vessel should carry cargo, the Port of Discharge for that cargo should be the last port on the route.

The logistics management functions required for operating the Vessel Trains are shown in Figure D.7.

- A1. The Lead Vessel is monitored at all times in order to have full visibility of the Vessel Train movement.
- A2. When a Vessel Train approaches a port and there is a Follower Vessel there ready to join the Vessel Train, the logistics management system will accept the Follower Vessel in the Vessel Train and now know exactly the cargo that is being transported.
- A3. Once approaching the PoD for a given Follower Vessel, the logistics management system will monitor the movement of the Follower Vessel from the Vessel Train to the PoD.
- A4. Status for all activities regarding Vessel Train movement and accepting and/or releasing Follower Vessels is reported to the logistics management system used.

Activity A2 and A3 are performed in each port along the route.

Figure D.7: Managing logistics during Vessel Train movements



9.4.2.3 Port of Discharge

At the PoD, cargo is received and unloaded from the Follower Vessel. Once that is done, port activities commence. These are illustrated in Figure D.8.

- A1. The Follower Vessel cargo will be discharged.
- A2. As the cargo is discharged, it will be scanned to ensure identity and to check the actions that need to be taken in the PoD related to each individual logistics unit.
- A3. If the arriving cargo need to be reconstructed (container stripped, cargo sorted and reconstructed either for movement to a new terminal or to the final address) that that process is performed.
- A4. If there is not enough cargo to utilise resources properly, some cargo may be kept in intermediate storage until the best possible utilisation is possible (provided that this can be done according to agreement between consignee and consignor).
- A5. When transport means are available, the cargo will be loaded and control given to the carrier (rail, road, inland waterway or costal shipping).

Status is reported in all operations.

Figure D.8: Execution at PoD