Project acronym: NOVIMAR
Project full title: Novel Iwt and Maritime Transport Concepts
Grant agreement No. 723009
Coordinator: Netherlands Maritime Technology Foundation

Deliverable 2.5: Check applicability in a different case study

Deliverable data

Deliverable No	2.5		
Deliverable Title	Check applicability in a different case study		
Work Package no: title	WP 2: Transport System		
Task(s)	T2.5 – Check applicability in a different case study		
Dissemination level	Public	**Deliverable type**	Report
Lead beneficiary	UAntwerp		
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Date of delivery	[31-01-2021]		
Approved	**Name (partner)**		**Date [DD-MM-YYYY]**
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Document history

Version	Date	Description
0.1	30/01/2021	First draft of deliverable uploaded in Emdesk
0.2	10/02/2021	Comments of peer reviewers processed (excluding the stakeholder meeting results).
0.3	23/03/2021	Inclusion of the stakeholder meeting results

The research leading to these results has received funding from the European Union Horizon 2020 Program under grant agreement n° 723009.

CONTENTS

List of symbols and abbreviations

BM	Business Model
CO	Cargo Owner
D2.5	Deliverable 2.5
FV	Follower Vessel
FVO	Follower Vessel Owner
IWT	Inland Waterway Transport
LV	Leader Vessel
MMMS	MIXMOVE Match Solution
RoRo	Roll on Roll off
SS	ShortSea Shipping
TC	Transportation Cost
T/F ratio	Total to full ratio of vessel
TLC	Total Logistic Cost
ToR	Terms of Reference
VO	Vessel Owner
VT	Vessel Train
VTO	Vessel Train organiser
WP	Work Package

1. EXECUTIVE SUMMARY

1.1 Problem definition

The business-economic viability of the vessel train (VT) has been examined for the Antwerp case, which was found to be positive for all the actors under certain scenarios, i.e. the vessel owner (VO), cargo owner (CO) and vessel train organiser (VTO). However, so as to enhance the above positive results of a well performing VT from a business-economic perspective, the VT performance has been also evaluated for another case, the Danube case. The Danube case is a very different case compared to the Antwerp case, with bigger shipping companies (which shows the need of focusing on business model 3 (BM3), i.e. one company owns all the fleet), with lower salaries compared to Western Europe, with more locks, with higher duration in the year of low water level, with very much lower Inland Waterway Transport (IWT) tonnages transported from which the highest percentage is bulk cargo, while the percentage of the containers transported is negligible and with 90% of the market being operated by pushed convoys, while in the Antwerp case study, this is not the case. With respect to the latter, this means that the IWT market in Danube which the VT can ‘’dive in’’ is 10% of the total IWT market in terms of the cargo volumes. Therefore, the research objective is to examine, if still the VT will be viable in such a different case, like the Danube case.

1.2 Technical approach and work plan

The three main objectives of the Deliverable 2.5 (D2.5) are: 1) to adapt the developed transport model from D2.4 for the Danube case study, 2) to benchmark the VT performance with respect to the second case study (Danube) and to research the capability of the VT in another region in Europe and 3) to establish Stakeholder Community effects and reactions to the VT capabilities. The three objectives were met following the sequence of the envisaged activities, as these are proposed in the NOVIMAR project proposal.

Subtask T2.5.1 aimed at ‘’Determining Terms of Reference (ToR) for the new case study’’. The goal of this task is to present all the key information needed for the Danube case. ToR of D2.5 come to gather and summarize also all the key findings and developments of all the previous deliverables of Work Package 2 (WP2), i.e. D2.1-2.4. More specifically, the ToR of D2.5 present the following:

- An overview of the Novimar transport model
- The data for the Danube case
- The Danube case study
- An overview of the BMs
- An overview of the VT capabilities and
- An overview of the scenarios

In the task 2.5.1, the model was adapted for the new Danube case study after doing modifications in the following sections: the CO analysis, the VT analysis and the IWT Route.

In task T2.5.3, the model was activated using the existing data of the current situation in the Danube case, so as to use these results as a baseline. The baseline scenario has been tested for both the BM3 and BM4.

In task T2.5.4, the model was modified with VT-operations, i.e. including the additional waiting times of the VT, reduced crew costs, extra leader vessel (LV) costs and extra VTO costs (for the BM4). In addition to these VT operations, the new VT capabilities were also included in the model, thanks to which the total/full (T/F) ratio decreases[1] and the congestion, the handling cost and time decrease as well. All these VT-related modifications in the model are made to evaluate the business-economic performance of the VT in the Danube case for one crew member on board and also for two crew members on board.

In task T2.5.5, the results of the baseline from T2.5.3 were compared with the results of the VT situation to see if the costs are less in the VT situation. If yes, then this means that the VT has positive business economic benefits. If there are positive benefits for all the actors, then the VT can be implemented.

In task T2.5.6, the results from the T2.5.3-T2.5.5 were analysed and presented to stakeholders to receive their feedback for any potential modifications that might be needed. Due to covid-19, the stakeholder meeting will take place in March 2021.

In task T2.5.7, in the case that the stakeholders suggest modifications, tasks T2.5.4-T2.5.6 were repeated.

The output of this deliverable will be used by D1.6, in which the final assessment of the VT concept will be made, showing if the VT concept is viable from an economic perspective (based on the present D2.5 and the previous D2.4), but also if it is viable with respect to its navigation aid and control system, its cargo systems & vessels and its safety level.

1.3 Results

This deliverable provides the main output of work done for task 2.5 in WP2 of the Novimar project. In this report, the economic viability of the VT concept is tested for the Danube case. The results of this analysis of D2.5 come to complement the findings of D2.4, in which the economic viability of the VT concept was tested for the Antwerp case. The main reason for re-doing the economic evaluation of the VT concept for a second case is mainly to ensure that the VT is economically viable in environments of different economic and navigational characteristics. An additional reason is to provide more enriched input to the VT handbook developed in D1.7. The VT handbook will be a web-based repository that will enable users to compile the relevant to them information from the handbook based on their interest, in order to create a VT service start-up. Therefore, the handbook will provide guidelines to

[1] Thanks to the pre-cargo consolidating system, vessels travel fuller.

actors interested in creating a VT service start -p (or joining the VT service) for both the West and East-European IWT market, either being VOs, COs or VTOs.

To do the analysis for the Danube case, new data had to be collected and further additions and improvements have been also made in the transport model. These results match with the set objectives of this deliverable.

1.4 Conclusions and recommendation

The business-economic evaluation shows that the only way that the VT concept can be economically viable in the Daube case study is by using the new cargo systems developed under WP4 that will allow the reduction of the cost and time of cargo handling. Based on the results, the main recommendations formulated are the following: BM3 to be applied and not BM4; one crew member to be on board and not two; the new cargo systems of Novimar vehicle and cross-transfer platform need to be used to make the VT economically viable.

2 INTRODUCTION

2.1 Task/Sub-tasks

The main task objectives are:

- To adapt the model from task 2.4 for the second case study.
- To benchmark the VT performance with respect to the second case study (Danube) and to research the capability of the VT in another region in Europe.
- To establish Stakeholders Community effects and reactions to the VT capabilities

Envisaged activities are:

- Sub-task T2.5.1: Determine Terms of Reference (ToR) for the new case study.
- Sub-task T2.5.2: Adapt the model developed in task T2.2 and adapted in task T2.4 for the new case study by introducing the relevant infrastructures and transportation services.
- Sub-task T2.5.3: Activate the model using existing data to validate the model reliability as a baseline.
- Sub-task T2.5.4: Modify the model with VT operations to reflect the new case study.
- Sub-task T2.5.5: Benchmark the new case study model from sub-task 2.5.4 to the baseline from T2.5.3.
- Sub-task T2.5.6: Analyse the results, including stakeholders' effects and reactions, and determine requirements for modification of the VT transport system concept from task T2.5.4.
- Sub-task T2.5.7: If necessary, modify the VT transport model and repeat T2.5.4-T2.4.6 activities.

  Sub-task T2.5.8: Prepare the task deliverable.

2.1 Analysis

D2.5 is the final deliverable of the WP2 and gathers and collects all the information and concepts developed in all the previous deliverables of WP2, i.e. D2.1-D2.4. The main developments throughout all these deliverables that are all used in the present D2.5 are the: 1) Novimar transport model, 2) the BMs and the 3) new VT cargo capabilities. The BMs and new VT cargo capabilities are used without further changes in them, while for the Novimar transport model additional changes are made in D2.5. With respect to the Novimar transport model, its main idea is that the costs of the current situation in the IWT market are calculated and compared with the costs of the VT situation, for all the actors. If the costs of the VT situation are less than the current ones, then there are benefits, for one or more actors. In order for the VT to be realised, all actors should have benefits, even if these benefits come as a compensation from one of the other actors and not due to the fact that the costs of the VT are less than the costs of the current situation. The distribution of benefits among actors is possible under the boundary condition that the net business-economic benefit of the actor that provides the compensation to another actor with no benefits is still positive after the benefit distribution.

2.2 Approach

Task 2.5 is the fifth and final task under Work Package (WP) 2 'Transport system model'. It started in month thirty-seven of the NOVIMAR project (June 2020) and ran until month fourty-five (February 2021). The deliverable was due end of month forty-five. The basic work consists of desk research and modelling. The work was mainly conducted by UA. Support was provided by PLIMs for the provision of data and by stakeholders who provided their feedback on the results of T2.5.1- T2.5.5. The output of this deliverable will be compared with the first case study of the VT (i.e. Antwerp case) in WP1.

3 PLAN

The main objective of this deliverable is to develop the second application of the VT concept in the Danube case study area.

3.1 Objectives

This deliverable has three main objectives:

- To adapt the model from task 2.4 for the second case study.
- To benchmark the VT performance with respect to the second case study (Danube) and to research the capability of the VT in another region in Europe.
- To establish Stakeholders Community effects and reactions to the VT capabilities.

3.2 Planned Activities

The planned activities of this deliverable are:

- Sub-task T2.5.1: Determine Terms of Reference (ToR) for the new case study.
- Sub-task T2.5.2: Adapt the model developed in task T2.2 and adapted in task T2.4 for the new case study by introducing the relevant infrastructures and transportation services.
- Sub-task T2.5.3: Activate the model using existing data to validate the model reliability as a baseline.
- Sub-task T2.5.4: Modify model with VT-operations to reflect the new case study.
- Sub-task T2.5.5: Benchmark the new case study model from sub-task 2.5.4 to the baseline from T2.5.3.
- Sub-task T2.5.6: Analyse the results, including stakeholders' effects and reactions, and determine requirements for modification of the VT transport system concept from task T2.5.4.
- Sub-task T2.5.7: If necessary, modify VT-transport model and repeat T2.5.4-T2.4.6 activities.
- Sub-task T2.5.8: Prepare the task deliverable.

3.3 Resources and involved partners

The distribution of the activities among the project partners in task T2.5 is the following:

UANTW (leader) will develop the ToR, adjust the model, prepare the input data with the assistance of PLIMS, run the model and analyse/present the results (workshop) to the Stakeholders Community with assistance from TUD.

Partners VML, DST, DUISP, MARLO, PLIMS, TRB actively support UANTW: analysis of results, modifications to the transport model.

3.4 Timeline

According to the Description of Action (DoA), Task 2.5 started at month thirty-seven and ended with deliverable 2.5 at month forty-five. The development of the content of the first version of this deliverable was finished at project month forty-four.

4 PLAN EXECUTION

4.1 Introduction

In this section, the short description of the performed activities of deliverable 2.5 is given together with factual deviations of the originally planned activities.

4.2 Performed activities

In order to develop the content of the first part of deliverable 2.5, the adjustments needed to the transport model and their reasons are explained. Secondly, the actual model was adapted and updated.

Sub-task 2.5.1

In task 2.5.1, the terms of references (ToR) are determined and presented for the new case study of the Danube, in which the overall objective of the study is defined. Also, in D2.5.1, it is explained how this objective will be developed and verified. An overview of the transport model is presented and, in addition, the adjustments that had to be made in the transport model in D2.5 are also presented. The main adjustments are the following: 1) the usage of the additional parameter ''% of cargo moved on IW transported in pushed convoys'', due to the fact that in the IWT market in the Danube region, 90% of the cargo is transported via pushed convoys, 2) the inclusion of the VTO costs and benefits, 3) the inclusion of the number of LVs in the route based on a newly defined formula and 4) the calculation of the VO benefits based on four consecutive steps: a) based on the VT characteristics, b) based on the LV characteristics, c) based on the Follower Vessels' (FVs) characteristics and d) based on the VTO costs. ToR present also the new data that were collected for the Danube case study, an overview of the BMs and VT capabilities developed throughout WP2 and an overview of the scenarios that were tested for the economic evaluation of the VT in the Danube region.

Sub-task 2.5.2

In this sub-task, the initial model was adapted to the needs to analyse the economic viability of the VT. In this task, the main Novimar related innovations are applied for the Danube case.

Sub-task 2.5.3

In this sub-task, the first calculations are done using the Novimar transport model to find the costs of both the VOs and COs in the current situation in the Danube region. These results will be used as the baseline with which the costs of the VOs and COs in the VT situation will be compared.

Sub-task 2.5.4

In sub-task 2.5.4, the model is modified with the VToperations to reflect the new case study, i.e. crew members are reduced to one and two crew members on board, VTO costs are added, waiting times are added due to the waiting of FVs for the LVs to depart at certain defined intervals. Moreover, the new VT capabilities are applied, i.e. being the new cargo systems and the pre-cargo consolidation capability. Thanks to these VT capabilities, congestion time in ports is reduced, cargo handling time and cost are reduced and also the vessels are more efficient, since they travel more fully loaded. The economic evaluation of the VT is examined with and without using these VT capabilities.

Sub-task 2.5.5

In sub-task 2.5.5, the results from the sub-tasks 2.5.3 and 2.5.4 are compared to see if the costs for the actors involved are higher in the current or in the VT situation. If the actors' costs are higher in the current situation, this means that the VT provides a cheaper service and thus it is economically viable. The VT concept is deemed economically viable even in the case that benefits are found not for all the actors involved, if there will be a compensation of the loss of the one actor by the other actor(s) that have benefits. However, this can be the case under the boundary condition that the net business-economic benefit of the actor that provides the compensation to another actor with no benefits is still positive after the benefit distribution.

Sub-task 2.5.6

In sub-task 2.5.6, the results are analysed by stakeholders, who give their feedback about the developed Danube case. Based on their feedback, if modifications in the VT transport system concept are required then changes need to be made under the sub-task 2.5.7. The following NOVIMAR partners are asked to provide feedback: VML, DST, DUISP, MARLO, PLIMS, TRB.

Sub-task 2.5.7

In this sub-task, the VT transport will be modified, if it is necessary based on the feedback of the stakeholders in T2.5.6 and then the activities T2.5.4-T2.5.6 will be repeated.

Sub-task 2.5.8

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

4.3 Deviations from the plan

The main deviation from the work plan is that a physical meeting and a large stakeholder meeting was not able to be held due to the limitations imposed by the different European governments to deal with the corona virus. This main stakeholder meeting will be held later in March 2021. The stakeholder meeting invitation is shown in Appendix D.

5 RESULTS

5.1 Introduction

In this section, the main results are given from the various performed activities in the seven sub-tasks as described in sections 3 and 4. The sub-tasks are structured according to the three explained objectives of this deliverable.

5.2 Determining the terms of reference (ToR) for the new case study (T.2.5.1)

In the task 2.5.1, the terms of reference (ToR) are presented, in which the overall objective of the study is defined. It also explains how this objective will be developed and verified. The aim of deliverable 2.5 is to ensure the general applicability of the VT by using a second case study, being the Danube case, and at the same time re-validating the transport model of van Hassel et al. (2018), which was updated in D2.4 and finally in the present D2.5. Lessons were learned by the Antwerp case, which most recent results are presented in D2.4. These lessons will be used for the application of the Danube case (when it is also possible thanks to data availability).

The version of the transport model of van Hassel et al. (2018) that was used in D2.4, will be also used for the D2.5, after doing some additional updates (see section 5.3 below).

Section 5.2 of the ToR defines the Danube case study, presents the data used for the case study's economic evaluation, gives an overview of the Novimar transport model, of the VT capabilities and of the scenarios used in the VT economic evaluation.

5.2.1 The Danube case study

The VT composition for the Danube case will be defined, based on the cargo volumes, as it has been done also for the Antwerp case. Since the network of Danube ports is very large, the present Danube case study will be narrowed down and only the ports with the highest cargo volumes will be selected to be included in the case study (Table 1). In 2019, the Danube ports with the highest freight traffic in millions of tonnes, were Galati in Romania (5.138), Izmail in Ukraine (4.283), Smederevo in Serbia (4.04) and Linz in Austria (3.28) (Danube Commission 2020b and 2020c).

Table 1: Danube ports

Germany	• Kelheim • Regensburg • Straubing • Deggendorf • Passau
Austria	• Linz • Enns / Ennsdorf • Ybbs • Krems • Korneuburg • Vienna
Slovakia	• Bratislava • Komarno • Sturovo
Hungary	• Györ-Gönyü

	• Budapest • Dunaujvaros • Dunavecse • Paks • Bogyiszlo • Baja • Mohacs
Croatia	• Osijek • Vukovar
Serbia	• Apatin • Bogojevo • Backa Palanka • Beocin • Novi Sad • Belgrade • Pancevo • Smederevo • Prahovo • Sremska Mitrovica • Sabac • Senta
Bulgaria	• Vidin • Lom • Oryahovo • Somovit • Belene • Svishtov • Ruse • Tutrakan • Silistra
Romania	• Moldova Veche • Orsova • Drobeta Turnu Severin • Giurgiu • Cernavoda • Medgidia • Murfatlar • Constanta • Braila • Galati • Tulcea
Moldova	• Giurgiulesti
Ukraine	• Reni • Izmail • Kilia • Ust-Dunaysk

Source: Danube Logistics Portal (2020) and Danube Commission (2020a).

In additional to the high cargo volumes, the availability of data was also the second key factor used when the route of the Danube case study is defined, presented in consecutive order:

- Regensburg (GERM),Passau (GERM)
- Linz (AUS), Vienna (AUS)
- Bratislava (SLOVAK)
- Györ-Gönyü (HUNG.), Dunaujvaros (HUNG.), Paks (HUNG.),
- Lom (BULG), Somovit (BULG), Ruse (BULG), Silistra (BULG)
- Drobeta Turnu Severin (ROMAN), Galati (ROMAN), Constanta (ROMAN)

5.2.2 Data for the Danube case

The type of data that was used for the Danube case is the same as that used for the Antwerp case, being cargo flows data, distance data (between ports' zones, ports), time data (congestion and dwell time, cargo handling speed), cost data (cargo handling cost, port dues, costs of road transport via truck per km and hour, VT equipment cost, crew costs etc.), road parameter data, inland vessel data, VT data, LV and FV data and VT effects. More specifically, the types of data used are shown below (see also Annex B).

Cargo flows data are yearly cargo volume for IWT and road for TEUs, Liquid and Dry cargo. Also, data are collected about the road distance kms between port zones, distance between ports (between port of origin and destination) and the maximum vessel class that can sail between each combination of ports, congestion at deep-sea ports, handling speed at deep-sea ports (TEUs, liquid and dry cargo), dwell time for cargo (days), handling cost (EUR/TEU & EUR/Ton for liquid and dry bulk), port dues inland vessels (EUR/Unit).

Road parameters collected are truck capacity (for TEUs, liquid and dry bulk), time of congestion, handling and waiting times at the port, cost per km, per hour and per hour of resting for both long distance trips (defined as 50< kms trip) and for pre- and post-haulage, inland cargo handling cost for truck (for TEUs, liquid and dry bulk), maximum driving time, rest time in operation, maximum driving time per day and the constants C1, C2 and C3 based on which the driving speed of the trucks is calculated in km/h.

Inland vessel data used are the class of the inland vessel, VT equipment cost, cargo capacity in tonnes and TEUs (designed capacity and load factor), bank interest rate, sailing regime, with or without bow thruster and depreciation inclusion.

Other used IWT costs are current crew cost (EUR/hour), VT crew cost (EUR/hour), miscellaneous costs (EUR/hour), capital cost (EUR/hour), depreciation costs (EUR/hour), VT equipment depreciation cost (EUR/hour), fuel cost (EUR/hour) (linked to the vessel speed), total anchor costs for current situation (EUR/hour), total anchor costs for VT situation (EUR/hour), total sailing costs for current situation (EUR/hour), total sailing costs for VT situation (EUR/hour), wages per crew rank (i.e. able seaman, engineer, officer with a patent and skipper) and number of crew members per rank on board.

Used IWT parameters are speed of the vessel, vessel class, cargo handling speed and time for the VT and current situation for containers, liquid, and dry bulk cargo.

VT effects[2] thanks to the VT capabilities are used: % of reduction of the cargo handling time, cargo handling cost, dwell time and congestion time in ports.

VT data are used: VT speed, VT departure intervals, % of reduction in cargo handing time, cost and congestion time in ports (which are linked to the aforementioned VT effects)[3].

LV and FV data are used: type of cargo, % of cargo handled, cargo handling speed, % of reduction of cargo handing time in ports, total cargo handling time for the LV and FV and the total handling time for a conventional vessel at the current situation.

5.2.3 An overview of the Novimar transport model

The transport model of van Hassel et al. (2018) was adjusted and updated, since its very first version presented in D2.2. of Novimar. Its latest version as presented in D2.4, which was used to do the calculations for the IWT case of Antwerp, calculates the VT cost savings from the perspective of the VO and CO and the VTO benefits. For the VTO, there are no savings calculated, since this is a new actor in the IW market, but the VTO benefits are calculated, which are costs for the VOs.

From the perspective of the VO, the VT cost savings are calculated in the way as shown in Equation 1, by deducting the costs that VOs have from using the VT from the costs that the VOs have in the current situation, when the VT is not used. If the result is positive, this shows that the costs in the current situation, when sailing without the VT, are higher than the costs when sailing with the VT. Thus, in this case, it is worth it from a business-economic perspective for the VOs to participate in the VT. The VOs' costs that are considered are the following: crew costs; fuel costs; capital costs; miscellaneous costs (store costs; general costs; repair & maintenance; insurance costs); costs during cargo handling operation and waiting costs for the VT (applicable only for the VT).

$$\text{VT cost savings} = \text{VO's costs}_{\text{CURRENT}} - \text{VO's costs}_{\text{VT}} \qquad \text{Eq. (1)}$$

From the perspective of the CO, the VT cost savings are calculated as shown in Equations 2 and 3, based on the Total logistics cost (TLC) formula (Blauwens et al., 2006). Equation 2 shows that TLC savings are calculated, when deducting the TLC of the VT situation, i.e. when the VT is used, from the TLC of the current situation, i.e. when the VT is not used. If the result is positive, this shows that it is worth it from a business-economic perspective for the COs to participate in the VT. In this case, there is an incentive for a modal shift for the CO. Equation 3 shows that the TLC is calculated by summing the transport costs, the annual costs of cycle stock, the inventory costs during transport and the safety stock cost of a shipment.

$$\text{Total logistics cost (TLC) savings} = \text{TLC}_{\text{CURRENT}} - \text{TLC}_{\text{VT}} \qquad \text{Eq. (2)}$$

[2] These data are based on assumptions.
[3] These data are based on assumptions.

$$TLC = TC + \left(\frac{1}{R}.\frac{Q}{2}.v.h\right) + \left(L.v.\frac{h}{365}\right) + \left(\frac{1}{R}.v.h.k.\sqrt{(L.d)+(D^2.l)}\right)$$ Eq. (3)

in which the parameters are the following: *TC*: Transport costs[4] (euro/unit), *R*: Annual volume (units), *Q*: Loading capacity (units), *v*: Value of the goods (euro/unit), *h*: Holding cost (% per year), *L*: Average lead-time (days), *k*: Safety factor (goods flow parameters), *d*: Variance of daily demand ($units^2$/day), *D*: Average daily demand (units/day), *l*: Variance of lead time ($days^2$).

From the perspective of the VTO, the total VTO benefits are calculated multiplying the profit margin for the VTO by the sum of the fixed and variable cost for the VTO (see Eq.4). The VTO benefits per segment are calculated proportionately to the benefits of VOs because it is the VOs that pay the VTO (see Eq.5).

VTO benefits (total) =(fixed cost of the VTO + variable cost of the VTO) * Profit margin Eq.(4)

VTO benefits (per segment) = VTO benefits (total) * [(VO benefits per year per segment / (sum of VO benefits per year of ALL segments)] Eq.(5)

The transport model and its respective software developed is user friendly, allowing the user to simply find out what the cost savings are for the case that he/she will select. The only thing that the user needs to do is select the segments that it wants to include in its IW trajectory, compose the desired VT with the desired number of FVs, the desired class, similarly for the LV, the desired type of cargo to be transported and the interval of departures. The interval shows the time between departures of the LV, like a regular train and it is advisable to be selected based on the available cargo flows in the selected segments.

The software is made to separately ''serve'' each of the main actors of the VT, being the CO, the VO and the VTO. Thus, depending on the perspective from which the VT analysis is done, the user can select the respective option in the software. For example, if the stakeholder interested in joining the VT is a CO, then there is an option for finding the cost savings for the CO. Similarly, for the VO. In D2.4, the VTO is the only main actor for whom cost savings were not directly calculated by the software. However, calculations were manually done (via the use of an Excel). Now, the model allows the software to directly calculate the VTO benefits (see also 5.3). The model is also adapted, so that the user can select one of the two cases, i.e. the Antwerp or Danube case, and then implement the new data in the model (see also 5.3).

5.2.4 An overview of the Business Models

In the deliverables of WP2, four BMs were developed to address the question about how to make the VT generate revenues and be economically viable. Out of the four initially developed BMs, the two are tested, being BM3 and BM4. Since these two were voted by relevant transport stakeholders in the IW

[4] For the calculation of the transport costs, crew costs, all other costs and fuel costs are included for both the VT and the current situation. The transport costs sum the total costs during sailing and anchor in euro per hour, they divide them by the cargo capacity, and they add also the cargo handling costs per unit in both the port of origin and destination. For the VT transport costs, reduced crew costs are used compared to the current situation transport costs.

sector (i.e. VOs, COs and intermodal logistics service providers, freight forwarders, brokers etc.) as the most realistic and most applicable for the VT. An overview of these two selected BMs is shown below.

- **BM3:** only one single shipping company owns the whole fleet in the VT and provides a liner service. There is no VTO fee in this BM because the VTO/LV and the FVs belong to the same shipping company and thus the fee that would be paid to the VTO otherwise, is considered as an internal cost for the shipping company.
- **BM4:** the VT provides a demand-based service and the VTO is a digital platform, i.e. a virtual service that makes use of an application for organizing the VT. In BM4, the VTO is paid by the Follower Vessel Owners (FVOs). The LV is assumed to be cargo LV and not dedicated LV at this stage of research. This means that the LV, except leading the VT, also transports cargo.

5.2.5 An overview of the VT capabilities

The transport model was adjusted in D2.4, to incorporate the new VT capabilities, being 1) the MIXMOVE Match solution developed by Marlo (MMMS) and 2) the new cargo systems developed in WP4, being 2a) the Roll on Roll off (RoRo) cross transfer platform and 2b) the NOVIMAR cargo handling vehicle.

The capability of MMMS refers to pre-sorting cargo/consolidating cargo that goes to the same destination and is loaded in one vessel. In this way, instead of vessels stopping in multiple terminals, they stop only at one, thus reducing the waiting times for the VT. Another advantage of the pre-sorting cargo capability is that the vessels are more efficiently used (i.e. it travels less empty).

The RoRo cross transfer platform is a floating platform that will allow cross docking of vessels, i.e. direct transfer of cargo between shortsea shipping (SSS) vessels and IW vessels. Thus, contributing to avoiding congestion at the terminal and resulting in shorter waiting times and shorter total transport times. Being designed for RoRo handling, this platform contributes to faster and cheaper cargo handling, when applicable. The NOVIMAR cargo handling vehicle is designed to lift a stack of two containers and transport them into the ship, while conventional vehicles cannot do that.

5.2.6 An overview of the scenarios

Three scenarios were tested in D2.5 based on the BMs 3 and 4 and based on the new VT capabilities. Similar scenarios were formulated also in D2.4 and adjusted according to the specific characteristics of the Danube case.[5]

- Scenario 1: BM3 application
- Scenario 2: BM4 application

[5] One of the scenarios of the D2.4 was about reducing congestion time, but in the Danube case of D2.5, since there is no congestion time, this scenario is not applicable. In D2.4 a second crew member has been added to see its impact on its economic viability, but since in the Danube case the economic viability has been already negative with one crew member, a second crew member has not been added and tested in the VT analysis. Also one of the scenarios in D2.4 has examined the impact of the pre-cargo consolidation by decreasing the total/full ratio, i.e. by making vessels travelling fuller. However, this scenario could not be tested in D2.5, since there was already insufficient cargo, thus by making the vessels more efficient, this would worsen the problem of insufficient cargo in the Danube region.

- Scenario 3: reducing both the time of handling by 25%, 50% and 75% in deep sea and inland ports compared to the baseline and reducing the cost of handling by 25%, 50% and 75% in deep sea and inland ports compared to the baseline.

5.3 Update of the Novimar Transport model (T.2.5.2)

In sub-task 2.5.2, the transport model was updated after doing modifications in the following: the CO analysis, the VT analysis and the IWT Route. New data were also used for the Danube case.

The adaptations made in the model in the ''CO analysis'' part are:

1. The parameter ''% of cargo moved on IW transported in pushed convoys'' was added.
2. The VTO costs and benefits are added in the model, for which new data are used for the Danube case (compared to the Antwerp case of D2.5).
3. The number of LVs is added in the model after being calculated based on a newly-added formula. Based on this formula, the number of LVs is calculated based on the distance between the two extreme ports (i.e. the very first port of the route and the very last port to which the LV sails), based on the sailing speed, the cargo handling time and the congestion time.

Adaptations in the model were also made in the ''VT analysis'' part.

1. The parameter ''% of cargo moved on IW transported in pushed convoys'' was added.
2. The creation of the VT is made in a different way, split in four steps:

Step 1) The VT characteristics are inserted (i.e. VT speed, VT departure interval, % of reduction (by the VT) in cargo handling time in ports, % of reduction (by the VT) in handling cost in ports, % of reduction (by the VT) in congestion time in ports and % of cargo moved on IW transported in pushed convoys.

Step 2) The LV characteristics are inserted (i.e. LV name, LV type, cargo handling %, cargo handling speed, % of reduction in cargo handling time in port, total cargo handling time LV (VT) and total cargo handling time current).

Step 3) The number and specific FV characteristics are inserted per segment (the FVs characteristics are the same with the LV characteristics presented above). A new model adaptation with respect to step 3 is that now, when adding the FVs, there is also the option ''add FVs to all segments'', thus facilitating and fastening the process for the software user.

Step 4) includes the addition of the VTO costs and benefits and of the number of the LVs.

New data are collected and used as input parameters in the model, i.e. vessel data, crew cost data, cargo capacity data. For the calculation of the cargo capacity, the average T/F ratio was recalculated and was found to be lower than the T/F ratio of the Antwerp case, meaning that the full vessels sailing in the Danube case are more. For the calculation of the cargo capacity, a different low water level duration was used, that was double the low water level duration used for the Antwerp case, which shows the higher importance of the low water level issue for the Danube case.

In additional to the above model adaptations, the new route was also added to the model, including 16 consecutive ports between Germany and Romania, which were selected based on their availability of data. For these ports, all the respective data were added: cargo flows for containers and bulk cargo, distances between them, handling speed, handling cost, congestion, and port dues.

To sum up, the main adjustments in the transport model are the following:

1) the usage of the additional parameter ''% of cargo moved on IW transported in pushed convoys'', due to the fact that in the IWT market in the Danube region, 90% of the cargo is transported via pushed convoys, 2
2) the inclusion of the VTO costs and benefits,
3) the inclusion of the number of LVs in the route based on a newly defined formula and the
4) calculation of the VO benefits based on four consecutive steps:
    1) based on the VT characteristics,
    2) based on the LV characteristics,
    3) based on the FVs characteristics and
    4) based on the VTO costs.

5.4 Developing the main results for the Danube case (T.2.5.3-2.5.5)

Section 5.4 presents the outcomes of the three following sub-tasks **2.5.3-2.5.5:**

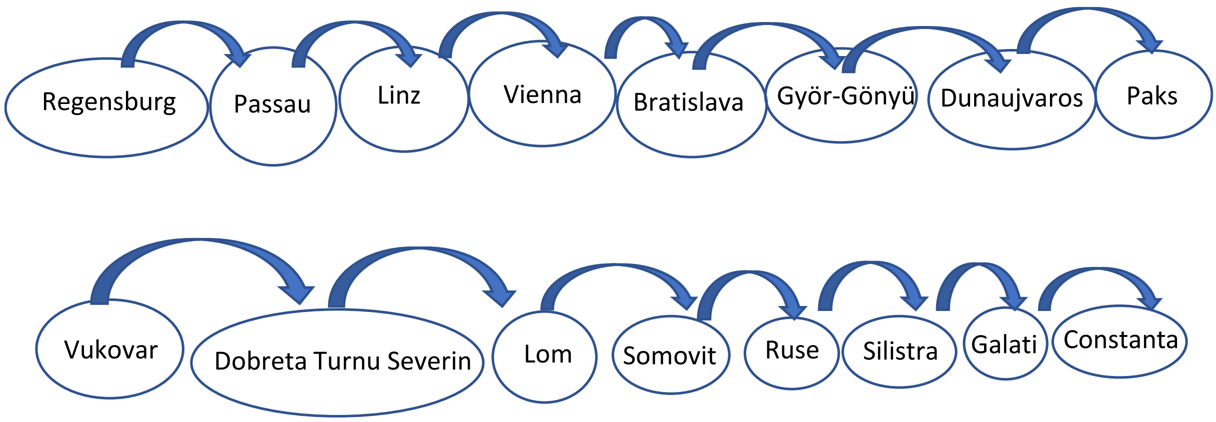
- Sub-task T2.5.3: Activate the model using existing data to validate the model reliability as a baseline.
- Sub-task T2.5.4: Modify model with VT-operations to reflect the new case study.
- Sub-task T2.5.5: Benchmark the new case study model from sub-task 2.5.4 to the baseline from T2.5.3.

In the following sections, the business-economic viability of the VT concept is evaluated for the Danube case from the perspective of three actors, the CO, the VO and the VTO. The VT costs for each actor are compared to the costs of the current situation to see if the VT provides benefits to them.

5.4.1 VT economic evaluation from the VO perspective-Vessel Train analysis

Vessel Train (VT) analysis is the first type of analysis conducted in this business-economic evaluation of the VT in the Danube region, while the second type of analysis is the CO analysis. The VT analysis is an analysis that evaluates the performance of the VT from the perspective of the VO primarily and of the vessel train organizer (VTO) secondarily, if the business model applied is the BM4 of the digital platform, in which the VTO and the VO are different actors and they do not belong to the same shipping company. Whereas, in BM3 of ''company owns all the fleet'', the VTO and the VO is the same actor and thus the VTO benefits do not need to be separately calculated, since the VTO is part of the one company operating the VT (for more information about the BMs see D2.2-D2.4).

The Danube case examined in D2.5 is composed of the following 16 consecutive ports.



For these 16 ports, there are 240 segments. A segment refers to a pair of ports in the predefined route (see also D2.4). The LV is the only vessel that travels through the whole route, i.e. from Regensburg to Constanta.

To reduce the complexity of the route, a few of these segments will be selected, which will be the ones showing the highest cargo flows between ports. Thus, from the 16 ports in total in our dataset, only the following eight highlighted ports are selected, being Passau (DE), Linz (AT), Vienna (AT), Bratislava (SK), Györ-Gönyü (HU), Somovit (B), Ruse (B) and Silistra (B).

Based on the available cargo flows, in these eight ports, the number of vessels per type of cargo was calculated (cargo volume check). The cargo volume checks are important because the VTs can only transport the quantity of cargo that already exists in the market, not more than this. This is the reason why it needs to be ensured that there is enough cargo to be transported by the VT and that the VTs are composed to serve the above goal. The present analysis serves not only as a business-economic evaluation of the VT concept but also provides guidelines to the stakeholders on the steps that they need to follow, so their VT can be economically viable, i.e. in which ports to operate for having the maximum benefits, which VT compositions are the appropriate ones based on the cargo flows and departure interval, and which BM is the most appropriate. This will also be an input to the VT handbook of WP1.

Table 2 shows the number of container and bulk vessels per segment based on their annual cargo flows, which is found after dividing the cargo flows by the cargo capacity of Johanna vessel in tonnes and TEUs, i.e. 2.295 and 191 respectively. Johanna is the type of vessel that will be used for composing the VTs. Due to limited availability of data only for this vessel type, the two VTs created in the present study are composed only by Johanna type of vessels. The characteristics of Johanna are listed below. An exploitation scheme, i.e. referring to the maximum number of hours allowed for sailing per day, has not been taken into account in the calculations of the NOVIMAR software, since the VT has been mainly applied for short sailing distances. However, the application of an exploitation scheme is expected to increase the VT benefits. This is due to the fact that the VT, thanks to operating semi-autonomously, provides the advantage of continuous sailing without the need of the vessel to stop for the crew to rest.

- Vessel name M/V "Johanna"
- Vessel value 800.000 EUR
- Length overall 101,88 m
- Beam 9,83 m
- Design draft 2,76 m
- Air draft 6,0 m
- Depth 2,50 m
- Cargo capacity / Design payload in TEUs and Tonnes - 1.806 DWCC/1.575 mto on 2,5 m 60 TEU, 2.500 cbm

Table 2 shows that dry bulk cargo is the most prominent type of cargo transported in the segments below. This finding is important because the type of LV that will be selected needs to be the type of cargo with the highest cargo flows. The bigger the cargo volume available to be transported, the lower the interval of departures between the LVs and thus the less waiting time.

Table 2: Number of vessels per type of cargo and per segment based on their cargo flows in a year

Segment		Number of container vessels	Number of liquid bulk vessels	Number of dry bulk vessels
Origin port	Destination port			
Somovit	Ruse	**19**	**3**	**70**
Ruse	Somovit	**19**	**3**	**70**
Vienna	Passau	24	29	53
Györ-Gönyü	Passau	23	7	46
Vienna	Linz	22	52	42
Bratislava	Linz	**22**	**52**	**42**
Vienna	Bratislava	21	32	43
Bratislava	Vienna	21	32	43
Györ-Gönyü	Linz	21	29	41
Györ-Gönyü	Vienna	21	10	41
Györ-Gönyü	Bratislava	21	10	10
Silistra	Ruse	8	3	32
Ruse	Silistra	8	3	31

Silistra	Somovit	8	3	31
Somovit	Silistra	8	3	30

Taking into account the above, the approach to design the VT and the base case route for the Danube region is the following.

Step 1: The segments and their ports with the highest cargo flows are selected out of the total 16 ports in the Danube case study, being Passau (GERM), Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), Györ-Gönyü (HUNG.), Somovit (BULG), Ruse (BULG) and Silistra (BULG).

Step 2: Further studying the cargo flows of these eight selected ports to identify the two extreme ports, i.e. the very first port and the very last port of the voyage. While initially Passau-Silistra were considered extreme ports based on step 1, after considering that there is almost no[6] cargo flow between these ports, two different extreme ports have been considered and thus a different route.

Step 3: identifying alternative extreme ports among the eight ones selected with the highest cargo volumes. To do that, Table 2 was re-examined and it was concluded that cargo flows are mostly divided in two parts, between 1) Germany and Hungary (with extreme ports Passau- Györ-Gönyü) & 2) inside Bulgaria (with extreme ports Somovit-Silistra). Thus, following the latter approach, there will be three VTs operating in the Danube case, one sailing from Passau to Györ-Gönyü and back again, a second one sailing from Somovit to Silistra and back again and a third one sailing from Somovit to Ruse and back again, i.e. only between two ports.

Step 4: With respect to the three routes created, one VT is mainly used: one LV transporting dry cargo, one FV transporting container cargo and one FV transporting liquid cargo. Thus, a VT of 3 vessels is composed. A second composition of VT has been also tested only for the first route (i.e. in the Analysis C), being the Passau-Györ-Gönyü: one LV transporting dry cargo and one FV transporting liquid cargo. For these two compositions of VTs, different intervals between departures are tested, i.e. 12, 24, 48 & 72 hours between departures and when needed additional intervals are also tested. The above are assumed firstly for a transport market in which 90% of the cargo is transferred by pushed convoys and secondly for a transport market in which 0% of the cargo is transferred by pushed convoys. The former means that the cargo volumes left for the VT to transport is only the 10% of the total IWT cargo volumes and the latter means that the cargo volumes left for the VT to transport is 100%. Initially, BM4 with a ''digital platform'' is assumed, which means that VTO costs are added as well and then BM3 of ''one company owning all fleet'' is assumed, which means that VTO costs are not added because are considered as internal costs of the shipping company.

To sum up, the routes that are examined in the Danube case study are three:

- **Route one: "Passau, Linz, Vienna, Bratislava, Györ-Gönyü''**

[6] The actual IWT cargo flow per year is 161 TEUs, 0 tonnes for liquid cargo and 450 tonnes for dry cargo. These cargo volumes represent the 10% of the total IWT cargo volumes that are transported by pushed convoys and thus only these are initially considered for the VT analysis. If the 100% of the IWT cargo volumes would be considered, the annual cargo volume would equal 1611 TEUs, 0 tonnes of liquid cargo and 4496 tonnes of dry cargo.

- **Route two: '' Somovit-Ruse-Silistra''**
- **Route three: ''Somovit-Ruse''**

Under the route one, analyses based on different scenarios were tested, being the following:

- **Analysis A1 (90%):** 90% of cargo transported via pushed convoys, BM4, VT composition: 1 dry cargo LV, 1 liquid cargo FV, 1 container cargo FV.
- **Analysis A2 (0%):** 0% of cargo transported via pushed convoys, BM4, VT composition: 1 dry cargo LV, 1 liquid cargo FV, 1 container cargo FV.
- **Analysis B:** 0% of cargo transported via pushed convoys, BM3, VT composition: 1 dry cargo LV, 1 liquid cargo FV, 1 container cargo FV.
- **Analysis C:** 0% of cargo transported via pushed convoys, BM3, VT composition: 1 dry cargo LV and 1 liquid cargo FV.

In appendix C, the results of the VT composed to operate in Danube region Passau- Györ-Gönyü can be seen. From this analysis the following key findings are found:

Route 1 "Passau-Györ-Gönyü"

Analysis A (Assumptions and characteristics)

- Assuming that 90% and 0% of the cargo is transported via pushed convoys. This assumption has been created and included in the analysis based on the existing IWT market in the Danube region, in which 90% of the cargo transported is transported via pushed convoys. Taken this characteristic of the market into account, this means that from the overall (i.e. 100%) annual cargo volumes in the Danube region, only 10% out of it is left to be transported via the VT. However, considering that this assumption limits a lot the available cargo volumes, an analysis is conducted without this assumption as well, i.e. assuming this time that 0% of the cargo is transported via pushed convoys.
- Assuming that BM4 is applied, which has been found to significantly increase the VT costs due the VTO costs.
- The VT composition used is: 1 dry cargo container LV, 1 container cargo FV and 1 liquid cargo FV.
- The intervals that will be tested this time are 12, 24 and 48 and 72 hours, which are found to increase the waiting time costs too much, thus making the VT concept non-viable economically.

Key findings of Analysis A

- There is not enough cargo to be transported by the VT in the Danube region, even in the selected route Passau-Györ-Gönyü, which has been found as one of the two routes with the highest cargo flows, when it is assumed that 90% of the cargo is transported by pushed convoys.

- There is enough cargo when it is assumed that 0% of the cargo is transported by the VT. The cargo is sufficient for one of the two directions of the LV extreme ports, i.e. there is enough cargo to be transported from Györ-Gönyü to Passau and not from Passau to Györ-Gönyü.
- The insufficient cargo volume in the Danube region leads to the need to increase the departure intervals. However, increasing the departure intervals means increase also of the waiting time costs and as a result decrease of the VT total benefits.
- The ideal interval time was found to be 48 hours, since it allows having enough cargo for the VT to transport and although it adds significant waiting time costs, it still gives positive total VT benefits (for only of the LV's segments, the Györ-Gönyü-Passau).
- It was observed that the highest waiting time costs are for the container FV, which has thre times higher waiting costs than the liquid FV.
- Not only the high waiting time costs make the VT concept non-viable from an economic perspective in the Danube region, but also the VTO costs, which add up to them (BM4).

Analysis B (Assumptions and characteristics)

- Assuming that 0% of the cargo is transported via pushed convoys, since the 90% assumption showed that there is insufficient cargo for the VT to operate.
- Assuming that BM3 was applied and not BM4, which was found to significantly increase the VT costs due the VTO costs.
- The same VT composition was used: 1 dry cargo container vessel, 1 container cargo FV and 1 liquid cargo FV.
- The intervals that were tested this time are 12, 24 and 48 hours and not 72 hours, which are found to increase too much the waiting time costs, thus making the VT concept non-viable economically.

Key findings of Analysis B

BM3 makes the VT economically viable, while BM4 cannot do it: Although there is still insufficient cargo (dry cargo since the LV transports cargo in this scenario) is a remaining problem in the Passau-Györ-Gönyü, as it has been found also in the Analysis A2 (0%), the new finding is that although the VT was found to be non-viable economically in the analysis A2 (0%) when using the BM4, it is economically viable, when using the BM3 (i.e. for the route Györ-Gönyü-Passau), thanks to the zero VTO costs in the BM3. This is good because the shipping companies in the Danube region match mostly the BM3 characteristics, being big shipping companies that can compose a whole VT only with their own fleet, and not small shipping companies (i.e. one company owns one vessel).

Analysis C (Assumptions and characteristics)

- Analysis B will be repeated after modifying the VT composition. In the analysis C, the one container FV will be excluded, since it was found that it has much higher waiting time costs compared to the liquid cargo FV. Thus, in the analysis C, the VT composition will be one dry cargo LV and one liquid cargo FV. The size of the vessels cannot be modified due to limited data availability only for the ''Johanna'' vessel.

The key finding of Analysis C is the following:

- Excluding the container FV from the VT makes the VT economically non-viable even for the segments for which it has been found to be viable, when the FV container was also included in the VT, together with the dry cargo LV and the liquid cargo FV.

Overall conclusion for route 1:

The reason why the VT was found non to be economically viable for the route Passau Györ-Gönyü is the fact that the VT has positive total benefits only for the voyage Györ-Gönyü-Passau and not for Passau-Györ-Gönyü. This is due to having sufficient cargo in the direction Passau-Györ-Gönyü. Therefore, since the VT travels in the same round trip multiple times a year, it is necessary to have benefits for both the directions of the voyage. This conclusion leads us to examining not only the initially planned route 2, i.e. Somovit-Ruse-Silistra (extreme ports for the LV: Somovit-Silistra) but also to examine a third route, the route Somovit-Ruse and Ruse-Somovit (extreme ports: Somovit-Ruse). What makes this route suitable to be examined is its characteristic of having the same cargo volumes in both directions of the voyage, something that it is not the case for the route 1, and this is the reason why it was found that VT is economically viable only for its way back for the route 1. Another positive characteristic of route 3 that makes it worthwhile of being examined is that it has the highest cargo volumes of dry cargo among all the examined segments in the dataset of ports, followed by a mediocre volume of containers and a very small negligible volume of liquid cargo. Thus, the VT composition that would match better for the route 3, taking into account the above, is oneone dry LV and one container FV and one liquid FV[7] OR one dry LV, one dry FV and one container FV and one liquid FV[8], if the remaining cargo for the FVs is high for the dry cargo.

Route 2: Somovit-Ruse-Silistra (extreme ports: Somovit-Silistra)

Route 2 will be tested using the lessons learned from the route 1. Considering that the route of route 2 has lower cargo volumes than the route 1, for all the three types of cargo, and considering that route 1 showed that even this one does not have sufficient cargo for both the directions of the voyage, this leads to the examination of:

- The scenario that 0% of the cargo is transported via pushed convoys.
- BM3 since it showed that this enforces the economic viability of the VT (and matches better the characteristics of the Danube region)
- All the intervals of departures, i.e. 12, 24, 48, 72 hours.
- The same VT composition , one dry cargo LV, one container FV and one liquid cargo FV (although the liquid cargo volumes are very low).

Key findings of route 2:

[7] Although the liquid cargo volumes are very low for Somovit-Ruse, Ruse-Somovit.
[8] Although the liquid cargo volumes are very low for Somovit-Ruse, Ruse-Somovit.

On the route Somovit-Ruse-Silistra (220 km), the VT is not economically viable for two reasons: firstly, due to insufficient cargo (12 h interval), and secondly, due to high waiting time costs when the interval is >12hours. Although when the interval is >12h, the cargo becomes sufficient thanks to the less frequent VT service, but then the VT benefits are negative due to the high waiting time costs. Thus, the VT is not economically viable in the route 2 ''Somovit-Ruse-Silistra'' (even with BM3 & 0% cargo transported via pushed convoys).

Key findings of route 3; Somovit-Ruse (100km):

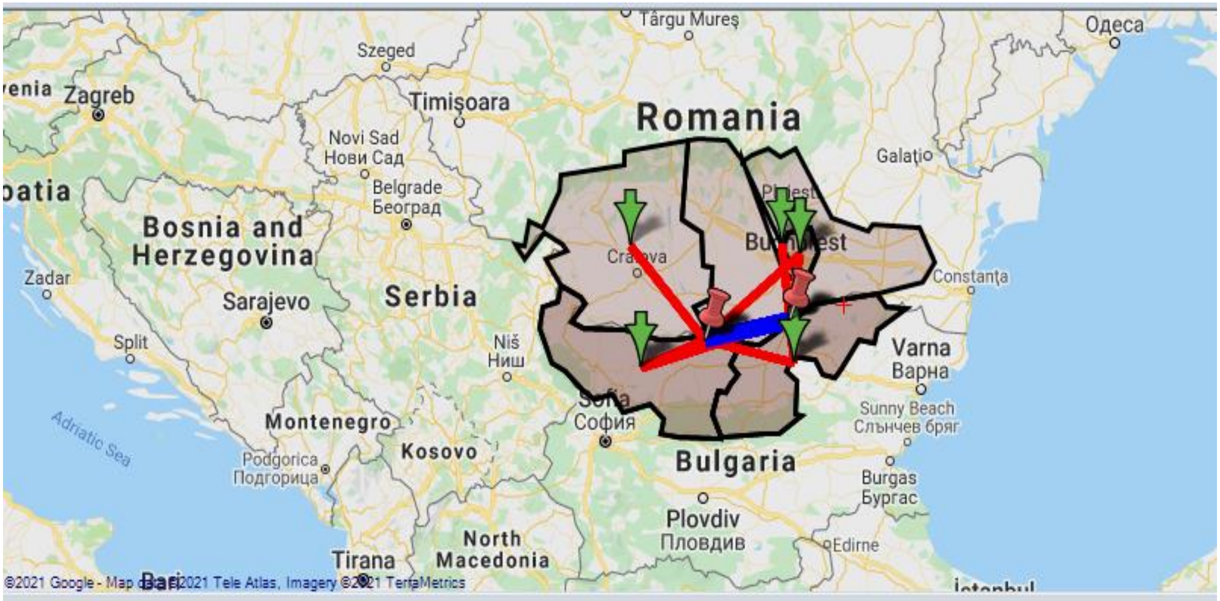
The VT is not economically viable due to the waiting time costs. In the route 3, insufficient cargo is not the problem, when using intervals of departures of 12, 24, 48 & 72 hours. Even when using a 12-hour interval, the remaining cargo that could still be transported (i.e. dry cargo) was still very high. Thus, the interval was reduced from 12 hours to 6 hours. Even when the interval was halved to 6 hours, the VT total benefits were still negative and the reason why is the waiting time costs (specifically in this case it was the waiting time costs of the LVs, not of the FVs, which exceeded the savings from the crew reduction). Also, for an interval of 6 hours, there is a shortage of cargo, which means that for such a frequent VT service, there were not enough tonnes of dry cargo for the VT to transport. In the transport model, this is called negative cargo differential or negative remaining cargo and shows that the VT cargo volumes are higher than the actual cargo volumes in the market due to the too high frequency of the VT departures or/and the insufficient actual cargo volumes. The cargo volume that the VT transports should be equal or less than the existing cargo volume currently transported in a conventional way. This is called ''cargo volume check'' in the transport model.

5.4.2 VT economic evaluation from the CO perspective

The analysis for the Danube case is the second conducted for the CO using as routes the ones that the VT analysis showed to be economically viable when the new cargo handling system developed in WP4 is used, being the routes Somovit-Ruse and Somovit-Ruse-Silistra.

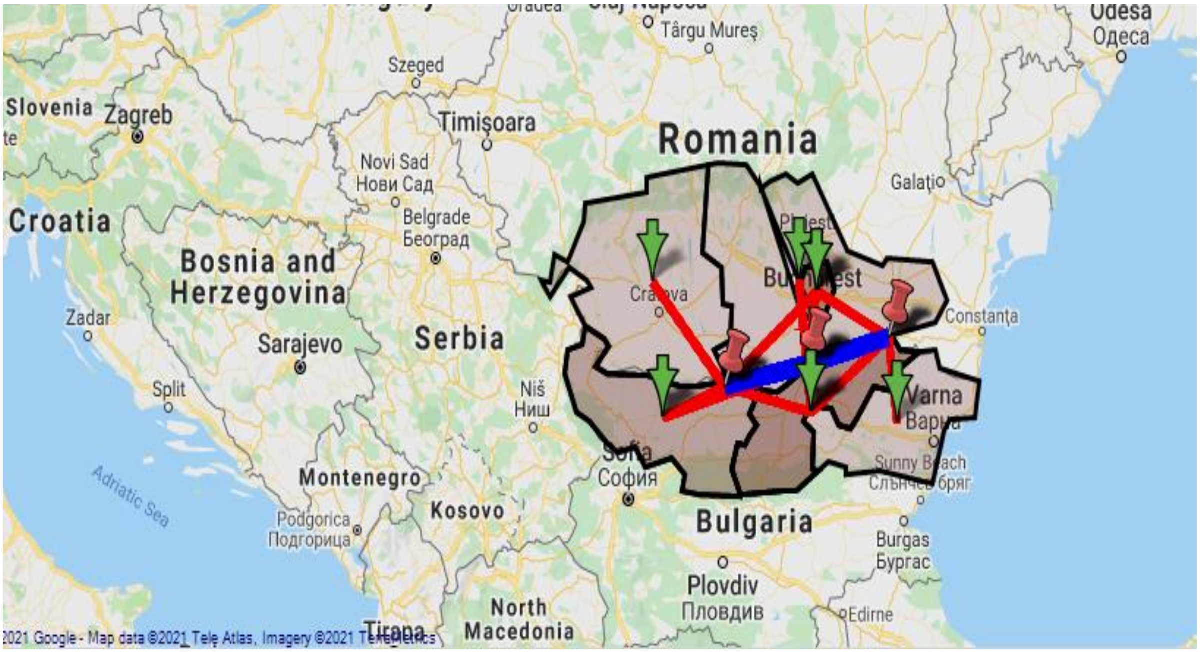
For the route Somovit-Ruse, the scenario of having 0% cargo transported via the pushed convoys, of a 12h interval, of 2 LVs, using BM3 and reducing cost and time of cargo handling by 25%, 50% and 75% was examined since this was the one that has showed positive business-economic benefits for the VOs (figure 1).

Figure 1: Map of the Somovit-Ruse route



For the route Somovit-Ruse-Silistra, the scenario of having 0% cargo transported via the pushed convoys, of a 18h interval, of 3 LVs, using BM3 and reducing cost and time of cargo handling by 25%, 50% and 75% was examined, since this was the second one that has showed positive business-economic benefits for the VOs (Figure 2).

Figure 2: Map of the Somovit-Ruse-Silistra route



The aim is to see if also the COs have benefits when using the VT in the routes in which it was found that the VOs have benefits, i.e. to find if there are TLC savings when using the VT, compared to using conventional sailing (Δ1).

The CO analysis is done per type of cargo, i.e. containers, dry and liquid bulk cargo because the ''successful'' VT has been found to be a mixed VT composed by one dry cargo LV, one liquid cargo FV and one container cargo FV.

Results are shown in Tables 3 and 4. The CO analysis shows that both routes that were found beneficial for the VOs, are also beneficial for the COs, with TLC savings for the Somovit-Ruse route between 19.06 euro/TEU and 53.37 euro/TEU for the container cargo, between 1.40 and 3.70 euro/ton for the liquid cargo and between 1.38 and 3.59 euro per ton for the dry cargo (Table 3). The TLC savings are almost the same also for the second route Somovi-Ruse-Silistra presented in Table 4.

Table 3: CO benefits for all types of cargo for the Somovit-Ruse route.

		Average for all segments (Δ1-TLC)		
Input parameters	Scenario: % of Reduction of cost and time of cargo handling	TEUs (EUR/TEU)	Liquid (Euro/tonne)	Dry (Euro/tonne)
-100 km - 0% of cargo transported via pushed convoys - 12 h interval - 2 LVs - BM3	25%	19.06	1.40	1.38
	50%	36.22	2.60	2.49
	75%	53.37	3.70	3.59

Table 4: CO benefits for all types of cargo for the Somovit-Ruse-Silistra route

		Average for segments (Δ1-TLC) Ruse ←→ Silistra			Average for segments (Δ1-TLC) Ruse ←→ Somovit			Average for segments (Δ1-TLC) Silistra <– > Somovit		
Input parameters	Scenario: % of Reduction of cost and time of cargo handling	TEUs (EUR/ TEU)	Liquid (euro/ ton)	Dry (euro/ ton)	TEUs (EUR/ TEU)	Liquid (euro/ ton)	Dry (euro/ ton)	TEUs (EUR/ TEU)	Liquid (euro/ ton)	Dry (euro/ ton)
-220 km - 0% - 18 h interval - 3 LVs	25%	19.20	1.40	1.40	19.06	1.40	1.38	20.23	1.50	1.50
	50%	36.37	2.50	2.50	36.22	2.60	2.60	2.50	2.49	2.60
	75%	53.50	3.70	3.60	53.37	3.7	3.59	54.53	3.80	3.70

5.5 Collecting stakeholder responses (T.2.5.6)

The stakeholder meeting was organized via the digital platform of MS Teams. The stakeholder meeting was split into two parts. Where in the first meeting the main focus was on shippers, while in the second the focus was on barge owners. In both meetings the following schedule was followed:

			Presenter
9:30	**9:40**	Introdcution	Erwin
9:40	**9:50**	Introduction of the main VT concept	Robin
9:50	**10:20**	Novimar developments + feedback from stakeholders	
		Cargo reconstruction	Jan Tore
		Cargo handling innovations	Bengt
		New VT vessels	Igor
10:20	**10:45**	Results IWT north Europe case + feedback from stakeholders 10 min pres 15 min feedback	Edwin
10 min break			
10:55	**11:20**	Results Short sea case + feedback from stakeholders 10 min pres 15 min feedback	Alina
11:20	**11:45**	Results IWT Danube case + feedback from stakeholders 10 min pres 15 min feedback	Edwin
11:45	**11:50**	Closing of the meeting	Erwin

At the stakeholder meeting the overall project was presented, along with the different Novimar developments. The overall concept and the Novimar innovations are combined in three different case studies. The last case studies (the Danube case) is part of this deliverable.

Danube case comments

1. Novimar partner comment (Igor Bačkalov): We keep going back to pushed convoys but we need to ask why pushed convoys are important now for Danube; due to low water level problems. Thus the vessels are designed to have low draught. Roro could bring advantages in the Danube. Why are there no containers in Daube? Because we do not know how to handle them in ports and this is the reason why Scandinaos designed the Novimar cargo handling vehicle.
2. Comment from chat (Guest):
    a. Everything changes if we would have an overall system/obligation to internalize the external costs for every transport mode.
    b. VT technology is easier to apply on waterways with few impediments for navigation (f.ex. locks, curbs in waterways, crosspoints). What is your reaction to these?

    Reply Novimar team: With respect to the first comment, we take them into account in WP1 and we calculate the welfare impact. With respect to the second comment, this is true. If we have too many obstacles, e.g. locks, bridges etc., this reduces the savings of the VT.
3. Comment of Novimar partner (Igor Bačkalov): About locks, there are certain areas in Danube with a few locks, which are 34 meters wide and thus quite spacious.

4. Novimar partner (Didier Bacon): do you think that the freight rates on the Danube can afford the investments of new vessels, new loading tools and adapt infrastructures?

   Reply Novimar team: The estimated costs for the VT equipment for a vessel to sail as a FV is 60,000-80,000 euro.

5. VO meeting attendant (J.A. Smallegange): Impact on human skill sets is out of scope of this project?

   Reply Novimar team: It is not out of scope. WP4 and WP5 took care of that.

5.6 Modifying the VT transport model based on the stakeholders' meeting (T.2.5.7)

From the main stakeholder meeting no new extra needs to modify the model are identified. From the stakeholder meeting became clear the Novimar innovations (cargo handling system, cargo reconstruction and the shallow water design of an inland vessel) will contribute to a better functioning of the VT and the IWT sector in general in Danube region.

6. ANALYSIS OF RESULTS

6.1 Summary of results

This deliverable developed the second case study, the Danube case study, in which the business-economic viability of the VT concept was evaluated. The transport model that is further updated in the present D2.5 of the WP2 was used. The two BMs 3 and 4 were applied, since they wer identified as the most appropriate ones based on interviews with the stakeholders from the sector in the previous deliverable (D2.4). The VT capabilities were also tested.

6.2 Analysis of results

Based on the performed VT analysis, three IWT VT route applications were developed: 1) Passau, Linz, Vienna, Bratislava, Györ-Gönyü, 2) Somovit, Ruse, Silistra and 3) Somovit, Ruse, due the fact that in these routes the highest cargo flows take place. The LV was always a dry cargo LV, because the highest cargo volumes in the Danube are dry cargo. Together with the dry cargo LV, two FVs were assembled, one container FV and one liquid cargo FV. The analysis was done assuming first that 90% of the cargo is transported by pushed convoys and secondly 0% of the cargo is transported by pushed convoys.

For these VT route applications, two business models were investigated. The first BM considers that all the vessels in the VT fleet are owned by one shipping company, BM3. This actor is also the one that is the VTO. The other BM that was investigated includes a platform that will organize and manage the compositions of the VT, i.e. BM4. In BM4, the cost and profit of such a platform is taken into account.

These extra costs were estimated to be 819.429,60 euro per year, including also the profit margin that is assumed to be 20% of the total VTO costs (based on the VT analysis). These VTO costs are the costs for the scenarios of having 20 LVs. The lower the number of the LVs needed for sailing from port A to port B and back, the less the VTO costs are in the BM4, and vice versa. The number of LVs was calculated based on the loop time divided by the departure intervals. These costs need to be recovered from the FVs and thus they are deducted from the FVs' benefits.

The results for the three route applications were negative, showing that the VT is not economically viable in the Danube case study. The reasons are three: firstly, there is not sufficient cargo for the VT to transport in the Danube region. Secondly, when there is enough cargo thanks to a lower frequency of VT departures, the waiting time costs are too high, leading to negative VT benefits. Thirdly, the cost savings obtained by applying the VT concept are lower, than in the Antwerp case, due to the fact that the wages of the crew are much less than in North-Western Europe.

VT benefits are less negative when using BM3, which means that extra VTO costs do not need to be added, because the VTO belongs to the same company that owns the whole fleet. For this reason and also due to the market structure of the Danube region, i.e. having larger shipping companies that can compose the VT using only their own fleet, BM3 is suggested to be applied for the Danube VT application.

The ''problem'' of having insufficient cargo flows could be mitigated in two ways Firstly, by assuming that 0% of the cargo is transported via pushed convoys, which means that 100% of the cargo flows could be used for VT transportation. This implies that push convoys can be part of the VT. Secondly, by increasing the departure intervals, which means that that the VT will depart less often and as a result it will transport less cargo. However, the disadvantage that the latter brings is the high waiting time costs due to the longer waiting times of the FVs.

For the results that showed that there was not sufficient cargo for the VT to operate, no further action could be taken. The market is not big enough to support the VT service. However, for the results that showed sufficient cargo but negative VT benefits, due to the high waiting time costs, further action is taken to reduce the excessive waiting time costs, through the application of the new VT capabilities. These are new cargo systems developed under the WP4, being the cross-transfer platform and the Novimar vehicle that contribute to the reduction of the time and cost of handling.

The analysis using the WP4 new cargo system shows that the VT becomes economically viable. Specifically, for the route ''Somovit-Ruse'' (12h interval, BM3), when cost and time of cargo handling decrease both by 25% & 75%, the VT benefits equal **4.5 million and 14 million euro** respectively for the VOs (based on the VT analysis). About 80 to 95% of these savings are contributed to the reduction in handling cost. The remaining savings are contributed to the savings on the crew cost (VT application of the FV). These extra savings come from the fact that also here the vessel turnaround time is reduced, which makes that the productivity of the VT goes up.

For the route ''Somovit-Ruse-Silistra'' (18h interval, BM3), when cost and time of cargo handling decrease both by 25% & 75%, VT benefits equal **8.5 million and 26.3 million euro** respectively for the VOs (based on the VT analysis). Therefore, the only way for the VT to be economically viable in the Danube region is by making use of the WP4 developments. In this case, about 80 to 95% of these savings are contributed to the reduction in handling cost. The remaining savings are contributed to the savings on the crew cost (VT application of the FV).

With respect to the economic-viability of the VT from the CO perspective, COs also have business-economic benefits for the two routes and scenarios for which the VO has been found to have benefits, being the 1) Somovit-Ruse route (100km, 0% of cargo transported via pushed convoys, 12 h interval, 2 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%) and the 2) Somovit-Ruse-Silistra (220km, 0% of cargo transported via pushed convoys, 18 h interval, 3 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%). The TLC savings are very similar for both routes and equal to **19.06 euro/TEU (container cargo), 1.40 euro/ton (liquid cargo) and 1.38 euro/ton (dry cargo)** for a 25% reduction of the cost and time of cargo handling**, 36.22 euro/TEU (container cargo), 2.60 euro/ton (liquid cargo) and 2.49 euro/ton (dry cargo)** for a 50% reduction of the cost and time of cargo handling and **53.37 euro/TEU (container cargo), 3.70 euro/ton (liquid cargo) and 3.59 euro/ton (dry cargo)** for a 75% reduction of the cost and time of cargo handling.

6.3 Corrective measures

Due to the COVID-19 restrictions, it was not possible to have a physical meeting with stakeholders to check the validity of the results. There an online stakeholder meeting was held to validate the obtained results. This meeting was scheduled later than initially foreseen.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

This deliverable examined the business-economic evaluation of the VT concept for the Danube case study. The transport model used in D2.4 was used after further adjustments. Two BMs were applied, BM3 in which one shipping company owns all the fleet in the VT and BM4 in which the VTO doing the VT management is a digital platform and does not belong to the same shipping company that owns the fleet.

Two types of analyses were conducted, the CO analysis and the VT analysis, examining the economic viability of the VT from the perspective of the CO and the VO respectively. The CO analysis calculates the TLC in the current situation and in the VT situation and compares them. If the former is higher than the latter ones, then there are TLC savings, and it is worth it from a business-economic perspective for the CO to join the VT. More specifically, the CO analysis calculates the TLC savings when transporting one unit of cargo from zone A to Zone B, by comparing two types of transportation, i.e. road-current IWT-road and road-VT waterborne-road.

The VT analysis calculates the annual VT costs for a voyage between Port A and Port B and the annual current costs for the same costs. If the latter are higher than the former, then there are VT benefits and thus there are benefits for the VO to join the VT.

In order for the VT to be realized, all the three main actors of the concept need to have economic benefits, the VO, the CO and the VTO. It is still possible for the VT concept to be realized, if the losses of one or two of the actors are compensated for by the benefits of the third actor that has benefits, under the boundary condition that this third actor that provides the support to the other two actors with the losses will continue to have benefits after the benefit distribution.

The business-economic evaluation of the VT concept in the Danube region showed that overall the main ''problem'' is the low cargo volumes and as a result the low frequency of VT departures, creating high waiting time costs. The VT concept was found to be non-economically viable from a VO perspective due to the above two reasons. The only way that can make the concept viable is the usage of the new cargo systems developed in WP4, i.e. of the Novimar vehicle and the cross transfer platform. These new cargo systems could be implemented in the route two ''Somovit, Ruse, Silistra'' (18h interval, 0% cargo transferred via pushed convoys & BM3) and in the route three ''Somovit-Ruse'' (12h interval, 0% cargo transferred via pushed convoys & BM3). Their implementation would decrease the cost and time of cargo handling and thus increase the VT benefits.

Specifically, the analysis showed that the implementation of the new cargo systems of WP4 leads to very high VT business-economic benefits that reach up to **26.3 million euro** (mainly caused by a reduction in handling cost) for the Somovit, Ruse, Silistra route. The VO analysis was conducted for the three routes with the highest cargo volumes: 1)Passau, Linz, Vienna, Bratislava, Györ-Gönyü, 2) Somovit, R use, Silistra and 3) Somovit, Ruse. The VT composition that was used for the analysis is a mixed VT composed by one dry cargo LV, one container FV and one liquid cargo FV.

The business-economic evaluation of the VT from the perspective of the CO showed that the VT concept is also economically viable. COs have also business economic benefits for the two routes and scenarios for which the VO was found to have benefits, being 1) the Somovit-Ruse route (100km, 0% of cargo transported via pushed convoys, 12 h interval, 2 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%) and 2) the Somovit-Ruse-Silistra (220km, 0% of cargo transported via pushed convoys, 18 h interval, 3 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%). The TLC savings are very similar for both routes and equal to **19.06 euro/TEU (container cargo), 1.40 euro/ton (liquid cargo) and 1.38 euro/ton (dry cargo)** for a 25% reduction of the cost and time of cargo handling**, 36.22 euro/TEU (container cargo), 2.60 euro/ton (liquid cargo) and 2.49 euro/ton (dry cargo)** for a 50% reduction of the cost and time of cargo handling and **53.37 euro/TEU (container cargo), 3.70 euro/ton (liquid cargo) and 3.59 euro/ton (dry cargo)** for a 75% reduction of the cost and time of cargo handling.

Overall, the only way that the VT concept can be economically viable in the Danube case study is by using the new cargo systems that will allow the reduction of the cost and time of cargo handling. Taking the above results into consideration, a social welfare assessment will be done, to calculate the external costs' savings thanks to the VT (WP1). Therefore, it will be seen, if subsidies can be given in order to implement the VT concept.

7.2 Recommendations

Based on the results of the business-economic evaluation of the VT in the Danube region, the following recommendations are formulated:

- BM3 to be applied and not BM4.
- One crew member to be on board of each FV.
- The new cargo systems of Novimar vehicle and cross-transfer platform need to be used to make the VT economically viable for a private point of view.
- Small-size vessels to be used to due to low cargo volumes.
- Dry cargo vessel to be used as LV, since this is the type of cargo with the highest flows in the Danube region.
- Departure intervals to be up to 48 hours, because if the intervals are higher, waiting time costs are too high, making the VT concept non-viable economically.
- A mixed VT to be used: one dry cargo LV, one container FV and one liquid cargo FV.

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9 ANNEXES

9.1 Annex A: Public summary

This deliverable examined the business-economic evaluation of the VT concept for the Danube case study. The transport model used in D2.4 was used after further adjustments. Two BMs were applied, BM3 in which one shipping company owns all the fleet in the VT and the BM4 in which the VTO doing the VT management is a digital platform and does not belong to the same shipping company that owns the fleet.

Two types of analyses were conducted, the CO analysis and the VT analysis, examining the economic viability of the VT from the perspective of the CO and the VO respectively. The CO analysis calculates the TLC in the current situation and in the VT situation and compares them. If the former is higher than the latter ones, then there are TLC savings and it is worth it from a business-economic perspective for the CO to join the VT. More specifically, the CO analysis calculates the TLC savings when transporting one unit of cargo from zone A to Zone B, by comparing two types of transportation, i.e. road-current IWT-road and road-VT waterborne-road.

The VT analysis calculates the annual VT costs for a voyage between Port A and Port B and the annual current costs for the same costs. If the latter are higher than former, then there are VT benefits and thus there are benefits for the VO to join the VT.

In order for the VT to be realized, all the three main actors of the concept need to have economic benefits, the VO, the CO and the VTO. It is still possible for the VT concept to be realized, if the losses of one or two of the actors are compensated for by the benefits of the third actor that has benefits, under the boundary condition that this third actor that provides the support to the other two actors with the losses will continue to have benefits after the benefit distribution.

The business-economic evaluation of the VT concept in the Danube region showed that overall, the main ‘’problem’’ is the low cargo volumes and as a result the low frequency of VT departures creating high waiting time costs. The VT concept was found to be non-economically viable from a VO perspective due to the above two reasons. The only way that can make the concept viable is the usage of the new cargo systems developed in WP4. Then, the VT has very high business-economic benefits that reach up to **26.3 million euro** for the Somovit, Ruse, Silistra route. The VO analysis was conducted for the three routes with the highest cargo volumes: 1)Passau, Linz, Vienna, Bratislava, Györ-Gönyü, 2) Somovit, R use, Silistra and 3) Somovit, Ruse. The VT composition that was used for the analysis is a mixed VT composed by one dry cargo LV, one container FV and one liquid cargo FV.

The business-economic evaluation of VT from the perspective of the CO showed that the VT concept is also economically viable. COs have also business economic benefits for the two routes and scenarios for which the VO has been found to have benefits, being 1) the Somovit-Ruse route (100km, 0% of cargo transported via pushed convoys, 12 h interval, 2 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%) and 2) the Somovit-Ruse-Silistra (220km, 0% of cargo transported via pushed convoys, 18 h interval, 3 LVs, BM3 and reduction of cost and time of cargo handling by 25%, 50% and 75%). The TLC savings are very similar for both routes and equal to **19.06 euro/TEU (container cargo), 1.40 euro/ton (liquid cargo) and 1.38 euro/ton (dry cargo)** for a 25%

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Overall, the only way that the VT concept can be economically viable in the Danube case study is by using the new cargo systems that will allow reducing the cost and time of cargo handling. Taking the above results into consideration, a social welfare assessment will be done, to calculate the external cost savings thanks to the VT (WP1). Therefore, it will be seen if subsidies can be given in order to implement the VT concept.

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9.2 Annex B-1: Overview of Container cargo flow between zones in Danube region

IWT	AT12	AT13	AT31	BG31	BG32	BG33	DE22	DE23	HR02	HU22	HU10	HU21	HU33	RO22	RO31	RO32	RO41	RO42	SK01
AT12	37.8221	0	0	0	407.1334	0	25.31865	448.799	0	0	0	0	0	2146.716	280.3835	0	424.2595	0	0
AT13	0	0	0	220.3484	72.78822	0	88.67515	33.85542	0	8.509334	0	0	0	140.1917	140.1917	0	0	0	0
AT31	637.8941	0	0	0	185.3631	0	327.8487	2126.359	1038.582	182.6913	0	52.25282	22.02742	146.0298	140.8769	0	238.5397	0	880.6779
BG31	146.7499	9.008413	489.2727	18850.4	48.84344	0	4319.001	141.08	8.836085	0	0	803.4216	0	9254.6	213.8489	0	0	0	0
BG32	453.2745	244.3534	872.2194	0	15285.57	0	2308.785	297.6687	8.836085	0	0	0	0	8211.703	749.4585	0	304.7596	0	82.36287
BG33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE22	494.435	136.3782	1057.173	31.42438	996.4835	0	736.9205	2698.611	122.915	0	0	182.1829	48.66118	192.4505	0	0	0	0	0
DE23	485.3565	33.99874	3789.794	201.6892	429.7539	0	1218.937	0	93.03995	0	0	0	97.13608	778.881	404.905	0	0	0	0
HR02	6.443151	0	237.2335	0	0	0	313.3204	86.73439	0	0	0	0	0	2944.97	290.8168	0	117.2287	0	0
HU22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HU10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HU21	419.1349	105.4843	211.3714	5.407769	488.9849	0	454.6373	609.5162	0	0	0	0	0	8441.302	0	0	0	0	0
HU33	90.6864	0	365.176	0	20.38689	0	2923.646	1711.92	32.98963	0	0	0	65.16112	15036.09	0	0	0	0	0
RO22	744.8238	86.41878	2586.964	118.5994	1875.392	0	538.8023	56.84925	34.1047	0	0	5406.735	2681.394	185980.6	56189.52	0	1153.222	0	331.7117
RO31	277.8251	0	35.92999	0	289.8267	0	60.98242	30.49121	0	0	0	0	0	45343.45	3373.275	0	602.8799	0	0
RO32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RO41	123.0492	0	53.89499	0	5.48879	0	0	431.683	0	0	0	46.62283	0	30343.92	442.4203	0	234.1415	0	0
RO42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SK01	1116.767	177.5436	39375.34	0	164.862	0	3302.183	574.2523	0	0	0	0	0	2170.929	0	0	0	0	359.1344

9.3 Annex B-2: Overview of dry bulk cargo flow between zones in Danube region

IWT	AT12	AT13	AT31	BG31	BG32	BG33	DE22	DE23	HR02	HU22	HU10	HU21	HU33	RO22	RO31	RO32	RO41	RO42	SK01
AT12	0	0	0	776.1513	4155.744	0	0	535.5277	910.191	0	0	0	0	6272.36	568.6125	0	811.6511	0	0
AT13	3996.723	0	10972.87	350.5537	122.7917	0	59.65073	0	910.191	0	0	1383.71	0	284.3058	284.3058	0	0	0	99.48114
AT31	8316.901	3332.907	0	3905.373	1743.97	0	80679.04	80924.68	57999.15	43352.86	0	44707.64	22437.3	8544.932	16780.64	0	16512.9	0	31162.47
BG31	354.951	0	1013.332	856323.6	207.6193	0	1522.315	641.7357	0	0	0	34966.23	0	6497.363	5362.103	0	0	0	0
BG32	35362.65	354.951	1830.942	23235.97	698956.8	0	1590.871	540.0452	0	0	0	0	0	163239.4	18967.53	0	0	0	3606.532
BG33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE22	5838.228	0	27402.54	0	1834.835	0	0	3364.817	228.4552	0	0	325.1987	0	0	0	0	0	0	0
DE23	13074.16	2273.184	109201.5	0	917.4173	0	3020.721	0	4333.149	0	0	0	1840.65	124.9439	5824.378	0	0	0	0
HR02	8088.087	0	2490.501	0	0	0	5063	818.0247	191997.9	709.9448	0	0	709.9458	91209.72	15198.08	0	5809.006	0	0
HU22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HU10	0	0	0	0	0	0	0	0	0	0	0	0	0	5049.719	0	0	0	0	0
HU21	3904.618	428.3363	12966.33	0	841.0542	0	8412.501	12081	0	0	0	0	0	4242.02	0	0	0	0	0
HU33	0	0	2524.992	0	0	0	2365.163	798.8254	0	0	0	13037.07	6370.612	3764.068	0	0	0	0	0
RO22	34827.58	1355.458	123249.3	9231.553	34715.72	0	23358.36	93.53197	7504.411	0	0	875838.2	268581.9	8686580	1761073	0	34495.14	0	25354.43
RO31	17240.65	0	0	0	2153.114	0	0	0	0	0	0	0	0	1542855	146898.6	0	15483.28	0	0
RO32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RO41	0	0	4227.775	0	0	0	0	0	371.6648	1586.547	0	0	1586.547	714288.2	11800.21	0	10114.47	0	0
RO42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SK01	13329.26	1837.829	930693.4	0	947.8513	0	101864.3	18243.37	0	0	0	0	0	155851.7	0	0	0	0	17718.57

9.4 Annex B-3: Overview of liquid bulk cargo flow between zones in Danube region

IWT	AT12	AT13	AT31	BG31	BG32	BG33	DE22	DE23	HR02	HU22	HU10	HU21	HU33	RO22	RO31	RO32	RO41	RO42	SK01
AT12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AT13	31205.06	0	494945.6	776.1523	0	0	0	0	0	0	0	3307.722	0	0	0	0	0	0	7393.986
AT31	0	0	0	0	0	0	220.9719	108.5559	0	123.334	0	127.1889	0	0	0	0	0	0	0
BG31	0	0	0	1034.934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BG32	0	0	0	6749.842	68471.67	0	0	0	5296.94	0	0	0	0	6497.365	0	0	0	0	0
BG33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DE22	0	0	1858.506	0	0	0	0	205.8528	0	0	0	0	0	0	0	0	0	0	0
DE23	181.3184	37305.81	1999.531	0	0	0	0	0	0	0	0	6225.179	0	0	0	0	0	0	0
HR02	0	0	0	0	0	0	0	0	6215.674	0	0	0	0	0	0	0	0	0	0
HU22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HU10	0	0	0	0	0	0	0	0	0	0	0	0	0	227774.3	0	0	0	0	0
HU21	116357.6	0	59506.16	0	0	0	106271.3	55227.79	0	0	0	13325.98	0	0	0	0	0	0	0
HU33	0	0	0	0	0	0	0	0	0	0	0	288.9114	0	0	0	0	0	0	0
RO22	0	0	369.952	22565.14	106500.7	0	0	0	6602.381	0	0	20753.29	24038.78	780064.3	71830.8	0	93139.01	0	13321.82
RO31	0	0	0	0	0	0	0	0	0	0	0	0	0	1476.621	0	0	0	0	0
RO32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RO41	0	0	0	0	0	0	0	0	17471.56	0	0	0	0	0	0	0	0	0	0
RO42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SK01	518628.8	82897.72	151806.4	0	0	0	8587.349	0	0	0	0	0	0	215485.6	0	0	0	0	0

9.5 Appendix C: Results of detailed VT analysis

Type of analysis	**VT composition** [9]	Danube Route	Distance between extreme ports (km)	% of cargo transported via pushed convoys	Interval between departures	Number of LVs	BM	Cargo differential for the LV (cargo: in tonnes)	Final VT Benefit Euro/Segment (From VT + Cargo Handling - VT Organiser)	Sum of total VT benefits for all segments
Route one Analysis A1 (90%)	1 LV: dry 1 FV: liquid 1 FV: containers	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.)**	1245.58	90%	12[10]	20	BM4	Passau- Györ-Gönyü: -890.536 Györ-Gönyü-Passau: -792908	-207134 -722861	-8.307.131
Analysis A2 (0%)	Same	**Same**	Same	0%	Same	Same	same	Passau- Györ-Gönyü: -823.473 Györ-Gönyü-Passau: 152812[11]	-196612 -119324	-5703681
Analysis B	Same	Same	same	0%	same	Same	BM3	-823473	-165681 492953	2537647

[9] (only Johanna vessels) 191 OR 2.295 tonnes cargo capacity.

[10] 730 departures a year.

[11] It is interesting that this is the only segment for which positive cargo flows differential have been found. However, the total VT benefits that include also the VTO costs are negative. The reason why the VT benefits are negative are the VTO costs. The segment's VT benefits are positive and equal to 492,953 euro per segment from FVs. However, the VTO costs equal -612,277 euro per segment, which after summing them with the VT benefits, it finally gives the negative figure of -119,324 euro of total VT benefits. This leads to the understanding that if BM3 is applied, and not BM4, this will lead to positive total VT benefits, because in the BM3 VTO is part of the same shipping company and not a third party for which an additional payment is made. Thus, when assuming that 0% of the cargo is transported by pushed convoys and thus the total IWT cargo flows can be transported by the VT, reduces somewhat the negative cargo differential for the route Passau-Györ-Gönyü but still is negative and makes the reverse route Györ-Gönyü-Passau to have positive cargo flows differential, which is the difference between the actual existing cargo volume in this specific route and the cargo volume that the VT is estimated to finally transport based on the specific departure frequency that has been selected.

								152812[12]		
Analysis C	1 LV: dry 1 FV: liquid	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.)**	1245.58	0%	12	20	BM3	-823473 152812	-177390 -1200[13]	1523847
Route two	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	12	4	BM3	Somovit-Silistra -198823[14] Silistra-Somovit -175795	1241877 1262188	11816867
Route three	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse**	100	0%	12	2	BM3	**Somovit -Ruse** 716867 (dry cargo in tonnes)	-157288 -157329	-314617[15]

[12] The cargo flows differential of dry bulk remain the same with the scenario a (0%), since the same assumption has been used that 0% of the cargo is transported via pushed convoys. What changes in this scenario of Analysis B is that BM3 is applied, which means that the extra VTO costs added in the VTO costs are zero. The non-inclusion of VTO costs reduced the negative VT total benefits for the segment Passau-Györ-Gönyü (for which there is not sufficient cargo for the VT anyway) and made the negative VT benefits for the reverse segment Györ-Gönyü-Passau positive, i.e. an increase from -119,324 euro total VT losses per year to 492,953 VT benefits per year.

[13] Taking out the container FV leads to negative total VT benefits, i.e. the VT benefits reduce from 492,953 euro a year to -1,200 euro a year, when the only change that has been done in the scenario is excluding the one container FV from the VT and keeping only one liquid FV to be attached to the dry LV. The reason why the container FV has been excluded in the analysis C is because analysis B showed that the waiting time costs of the container FV are much higher than the waiting time costs of the liquid FV, due to the fact that the frequency of departure for the container FV was higher than the liquid FV. Thus, it can be concluded that when the interval is small, i.e. 12 hours, the VT should be the original one, composed by 1 dry cargo LV, 1 container FV and 1 liquid FV. However, the next analysis with higher intervals could show that when intervals are higher (24, 48, 72 hours), excluding the container FV might have a positive impact on the economic viability of the VT concept.

[14] This shows that for a departure interval of 12 hours, there is not enough cargo. Specifically, while the LV cargo capacity for an interval of 12 hours is 897,987.6 tonnes of dry cargo, the actual dry cargo volume for the segment Somovit – Silistra is only 699,165, thus giving a negative cargo differential for the dry cargo LV of -198,823 tonnes.

[15] In the Somovit-Ruse route, there are only ports. Thus, the total VT benefits are the sum of the two extreme segments, i.e. Somovit-Ruse, Ruse-Somovit. However, this is not the case for the routes that include more than two ports and thus not only the extreme segments.

								-10(liquid cargo in tonnes) -32(TEUs) Ruse-Somovit 698373(dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)		
VT capabilities Applying scenario 5 of reducing time and cost of handling by 75% (keeping all the rest of the characteristics the same)								**Somovit -Ruse** 716867 (dry cargo in tonnes) -10(liquid cargo in tonnes) -32(TEUs) Ruse-Somovit 698373(dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)	7113833 7048443	14,162,276[16]
VT capabilities Applying scenario 5 of reducing time and cost of								**Somovit -Ruse** 716867 (dry cargo in tonnes) -10(liquid cargo in tonnes)	4690126 4646519	9336645[17]

[16] Application three becomes economically viable, when the cargo handling time and cost is reduced by 75%, thanks to the new cargo systems. Thus, the VT benefits from negative, -314,617 euro become positive and very high, 14,162,276 euro. From the 14,162,276 euro VT benefits, the 13,285,200 euro comes from VT benefits thanks to cargo handling.

[17] From the total VT benefits of 9,336,645 euro, 8,856,800 euro comes from benefits thanks to the cargo handling benefits.

handling by 50% (keeping all the rest of the characteristics the same)								-32(TEUs) Ruse-Somovit 698373(dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)		
VT capabilities Applying scenario 5 of reducing time and cost of handling by 25% (keeping all the rest of the characteristics the same)								**Somovit -Ruse** 716867 (dry cargo in tonnes) -10(liquid cargo in tonnes) -32(TEUs) Ruse-Somovit 698373(dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)	2266419 2244595	4,511,014[18]
Route three	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse**	100	0%	6	5	BM3	**Somovit -Ruse** -181120 (dry cargo in tonnes) -10(liquid cargo in tonnes) -32(TEUs) Ruse-Somovit -199614 (dry cargo in tonnes)	-122281 -122494	-244775

[18] From the total VT benefits of 4,511,014, 4,428,400 euro comes from benefits thanks to the cargo handling benefits.

								-10 (liquid cargo in tonnes) -39 (TEUs)		
[redacted]										
Route one Analysis A1 (90%)	1 LV: dry 1 FV: liquid 1 FV: containers	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.),**	1245.58	90%	24[19]	10	BM4	Passau- Györ-Gönyü: -441542 Györ-Gönyü-Passau: -343914	-193723 -463264	-4852318
Analysis A2 (0%)	same	same	same	0%	same	same	same	-374479 601806	-184730 55409[20]	-3742114
Analysis B	same	same	same	0%	same	same	BM3	-374479 601806	-167388 398,694[21]	878549
Analysis C	1 LV: dry 1 FV: liquid	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK),	1245.58	0%	24	10	BM3	-374479 601806	-177390 -23399[22]	610623

[19] 365 departures a year.

[20] This is the first time positive VT total benefits are found. This second scenario assuming 24 hours of departure interval showed positive benefits compared to the previous scenario assuming 12 hours of interval, thanks to the lower VTO costs, which has been almost halved thanks to the fact that frequency of departures is now half and as a result the number of LVs that operates in the route.

[21] When BM3 is applied VT total benefits increase from 55,409 euro per year to 398,694 euro for the segment Györ-Gönyü-Passau. However, for the reverse segment the application of BM3 reduced the total VT losses but not make them benefits.

[22] Excluding the container FV has a negative impact on the VT benefits also for the 24 hours interval scenario, the VT benefits decrease from -167,388 to -177,390 and from 398,694 to -23,399 euros a year for the segments Passau-Györ-Gönyü and Györ-Gönyü-Passau respectively. Thus, excluding the container FV makes the VT non-viable economically for the second segment, while it was economically viable when the container FV was included.

		Györ-Gönyü (HUNG.),							
Route two	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	24[23]	2	BM3	**Somovit-Silistra** 250171 (dry cargo in tonnes) -415 (liquid cargo in tonnes) -16[24] (TEUs) …. Silistra-Somovit 273199(dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)	-173083 … -172366[25]	-480596
Route two (NEW INTERVAL 18H)	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	18 (NEW INTERVAL)	3	BM3	**Somovit-Silistra** **100507** (dry cargo in tonnes) -415 (liquid cargo in tonnes)	-155495 … -154180[27]	-338524

[23] Since the VT benefits are negative for the interval of 24 hours for the application two, it is already known that the VT benefits will be negative for the intervals of 48 and 72 hours that have been tested for application one.

[24] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable since it is only 16 TEUs needed and 415 tones, which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).

[25] The VT is not economically viable due to the high waiting time costs. For example, for the segment Somovit-Silistra, the VT total benefits are negative, while there is sufficient cargo, due to the 12 hours waiting time. If the waiting time costs were not taken into account, then the VT total benefits would be positive for this segment and equal to 74,737 euro per year. But when the total VT waiting time costs are added, which are equal to -247,143 euro per year for this segment, then the VT benefits become negative and equal to 172,366 euro per year. Thus, what I could try is an interval between 12 and 24 hours, because a 12 hour-interval is too frequent and a 24 hour interval is too long.

[27] Although the negative VT benefits have been reduced from 172,366 euro per year to 154,180 euro per year, still the VT is non-viable economically. Thus, an additional interval will be examined ''12h<new interval<18h'' and specifically the interval of 15h will be examined.

								-16[26] (TEUs) …. **Silistra-Somovit** **123535** (dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)		
VT capabilities Applying scenario 5 of reducing time and cost of handling by 75% (keeping all the rest of the characteristics the same)								**Somovit-Silistra** **100507**(dry cargo in tonnes) -415 (liquid cargo in tonnes) -16[28] (TEUs) …. **Silistra-Somovit** **123535** (dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)	3,228,868 3,333,588	26,283,812[29]
Applying scenario 5 of reducing time and cost of								**Somovit-Silistra** **100507** (dry cargo in tonnes)	2100747 2170999	17,409,700

[26] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable, since it is only 16 TEUs needed and 415 tones which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).
[28] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable since it is only 16 TEUs needed and 415 tones which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).
[29] From which 25,555,470 euro comes from VT benefits from cargo handling.

handling by 50% (keeping all the rest of the characteristics the same)								-415 (liquid cargo in tonnes) -16[30] (TEUs) …. **Silistra-Somovit** **123535** (dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)		
								Somovit-Silistra **100507**(dry cargo in tonnes) -415 (liquid cargo in tonnes) -16[31] (TEUs) …. **Silistra-Somovit** **123535**(dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)	972626 1008409	8,535,587

[30] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable since it is only 16 TEUs needed and 415 tones which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).
[31] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable since it is only 16 TEUs needed and 415 tones which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).

Route two (NEW INTERVAL 15H)	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	15 (NEW INTERVAL)	3	BM3	**-19225**(dry cargo in tonnes) -415 (liquid cargo in tonnes) -16[32] (TEUs) ….. 3803[33] (dry cargo in tonnes) 185 (liquid cargo in tonnes) 30 (TEUs)	-146701[34] -145087[35]	-267488
Route three	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse**	100	0%	24	1	BM3	**Somovit -Ruse** 1165861 (dry cargo in tonnes) -10 (liquid cargo in tonnes) -32 (TEUs) Ruse-Somovit 1147367(dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)	-227298 -226999	-454297

[32] The cargo differential for the FVs might be negative, showing that there is not enough cargo TEUs and liquid cargo to transport in this segment Somovit -Slilistra, but it is still acceptable, since it is only 16 TEUs needed and 415 tones which equal 20% of the cargo capacity of the Johanna vessel (i.e. 2295 tonnes).
[33] Even if the cargo is sufficient, the VT benefits are negative due to the high waiting time costs.
[34] Although there are savings from the crew reduction, e.g. approx. 75,000 euro savings for the whole VT (the LV & the two FVs) compared to the current situation, these crew cost savings are outweighted by the waiting time costs, which equal 221,361 euro per year for the whole VT, thus giving finally negative VT benefits equal to -146,701 euro per year (for the segment Somovit-Silistra).
[35] The negative VT benefits have been reduced from 154,180 euro per year for an interval of 18 hours to 145,087 euro per year for an interval of 15 hours. Thus, the VT benefits still remain negative even if the interval is reduced to 15 hours.

[redacted]										
Route one Analysis A1 (90%)	1 LV: dry 1 FV: liquid 1 FV: containers	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.),**	1245.58	90%	48[36]	5	BM4	Passau- Györ-Gönyü: -217045 Györ-Gönyü-Passau: -119417	-187273 -347553	-3373619
Analysis A2 (0%)	same	same	same	0%	same	same	same	-149982 826303	-181350 1385[37]	-5249996
Analysis B	same	same	same	0%	same	same	BM3	-149982 826303	-170802 210174[38]	-2439662
Analysis C	1 LV: dry 1 FV: liquid	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK),	1245.58	0%	48	5	BM3	-149982 826303	-177390 -67796[39]	-1215827

[36] 182.5 departures a year.

[37] Although the cargo differential is positive and higher than the second scenario, it is found that the total VT benefits are only 1,385 euro, when interval is 48 hours compared to 55,409 euro when the interval is 24 hours. The reason why is the extra waiting time costs that the increased waiting time in the third scenario causes. For an interval of 24 hours the mean waiting is 12 hours. When multiplying the mean waiting time with the vessel anchor costs, then the waiting time costs are found. This for an interval of 48 hours, the mean time is double, i.e. 24 hours and as a result the waiting time costs are also double. Thus, it can be concluded that the VT can have an interval of up to 48 hours, so as to be economically viable, otherwise the high waiting time costs ''kill'' the economic viability of the concept.

[38] When applying BM3, VT benefits increase from 1,385 a year for the Györ-Gönyü-Passau and the VT losses decrease for the Passau- Györ-Gönyü from -181,350 to -170,802 euro per year.

[39] Excluding the container FV has also a negative impact for the 48 hours interval scenario. It reduced the total VT benefits from -170,390 to -177,390 and from 210,174 to -67,796 euro per year for the two extreme segments under examination. For the second segment, Györ-Gönyü-Passau, the VT benefits are turned from positive to negative.

		Györ-Gönyü (HUNG.)								
Route two	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	48	1	BM3	**Somovit-Silistra** **474668 (dry cargo in tonnes)** **-415 (liquid cargo in tonnes)** **-16 (TEUs)** **.....** **Silistra- Somovit** **497696 (dry cargo in tonnes)** **185 (liquid cargo in tonnes)** **30 (TEUs)**	**-243436** **-245110**[40]	**-1048885**
Route three	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse**	100	0%	48	1	BM3	**Somovit -Ruse** 1390358 (dry cargo in tonnes) -10 (liquid cargo in tonnes) -32 (TEUs) Ruse-Somovit 1371864 (dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)	**-367321** **-366339**	**-733660**

[40] When the interval increases from 24 to 48 hours, the cargo differential becomes even more positive, which means that there is even more cargo to be transported by the VT due to the less frequent VT departures, but the VT benefits become even more negative due to the higher waiting time and costs.

Analysis A1 (90%)	1 LV: dry 1 FV: liquid 1 FV: containers	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.),**	1245.58	90%	72	3	BM4	Passau- Györ-Gönyü: -142213 Györ-Gönyü-Passau: -44585	-184899 -312539	-2981113
Analysis A2 (0%)	same	same	same	0%	Same	same	same	-75150 901135	-182048 -133,336[41]	-7844072
Analysis B	same	same	same	0%	Same	same	BM3	-75150 901135[42]	-174218 21655[43]	-5757869
Analysis C	1 LV: dry 1 FV: liquid	**Passau (GERM),** Linz (AUS), Vienna (AUS), Bratislava (SLOVAK), **Györ-Gönyü (HUNG.)**	1245.58	0%	72	3	BM3	-75150 901135	-177390 -112194[44]	-3042274

[41] Although the cargo differential is positive in this segment, the total VT benefits are negative, due to the very high waiting costs of the two FVs, 432,364 euro per year for the container FV and 133,193 euro per year for the Liquid LV. Thus, the very high waiting time costs increase the VT costs, which when they are deducted by the costs of the current situation give a negative VT total benefit because the VT costs are then higher than the costs of the current sitiation. Between the two FVs, the waiting time costs of the LV are three times higher than the waiting time costs for the liquid FV. Thus, a scenario that could improve the economic viability of the VT is a VT with only one FV, i.e. a liquid FV.

[42] Remaining Cargo for FVs DryBulk (Ton/Year).

[43] Although the interval of 72 hours showed that the VT is non-economically viable, when applying BM4 due to the high waiting time costs, when applying BM3 even a 72 hour-interval allows the VT to be economically viable, with total VT benefits of 21,655 euro per year for the segment Györ-Gönyü-Passau and reduced the VT losses for the reverse segment, from -182,048 to -174,218.

[44] Excluding the container FV has also a negative impact for the 72 hours interval scenario. It reduced the total VT benefits from -174,218 to -177,390 and from 21,655 to -112,194 euro per year for the two extreme segments under examination. For the second segment, Györ-Gönyü-Passau, the VT benefits are turned from positive to negative.

Route two	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse** **Silistra**	220	0%	72	1	BM3	**Somovit-Silistra** 549500**(dry cargo in tonnes)** **-415 (liquid cargo in tonnes)** **-16 (TEUs)** …. **Silistra- Somovit** 572528 **(dry cargo in tonnes)** **185 (liquid cargo in tonnes)** **30 (TEUs)**	-313789 -317853[45]	-1617174
Route three	1 LV: dry 1 FV: liquid 1 FV: containers	**Somovit** **Ruse**	100	0%	72	1	BM3	**Somovit -Ruse** 1465190 (dry cargo in tonnes) -10 (liquid cargo in tonnes) -32 (TEUs) Ruse-Somovit 1446696 (dry cargo in tonnes) -10 (liquid cargo in tonnes) -39 (TEUs)	-507345 -505679	-1013024

[45] Same conclusion with the scenario of 48 hours for the application two, but now with the 72 hours interval cargo differential is even more positive but the VT benefits even more negative due to the very high waiting time costs.

9.6 Appendix D: Stakeholder meeting WP2

NOVIMAR
VESSELTRAIN

The Vessel Train (VT) concept has been developed and applied to three different cases. For these three cases we would appreciate an external view and reflection from sector specialist. Because the VT concept is linked to different actors in the hinterland supply chains, we will be organizing two separate stakeholder meetings. The first one is dedicated to shippers (cargo owners) and the second one is dedicated to the operators (barge owners, terminal operators and ports (authorities)).

In these meetings we (the project partners) will present our main findings of the project with a special focus on economic viability. During these meetings, we want to learn from your insights and opinions about the results that we have obtained, and see if and how these developments could be implemented.

This document is intended to provide all participants with a common starting point.
Please follow this link to register for the meeting: ....

Edwin van Hassel,
University of Antwerp

Alina Colling,
Delft Technical University

Invitation stakeholder meeting www.novimar.eu