Inter-terminal transport on Maasvlakte 1 and 2 in 2030

Towards a multidisciplinary and innovative approach on future inter-terminal transport options

Deliverable 0

Definition of common parameter values required for ITT system design

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Table of Contents

1 Introduction

The goal of the project "Inter-terminal transport (ITT) on Maasvlakte 1 and 2 in 2030 - Towards a multidisciplinary and innovative approach on future inter-terminal transport options" is to develop innovative, non-conventional concepts for ITT of containers in the port of Rotterdam. For exploring the possibilities of ITT, the focus is hereby explicitly put on the technological aspects of transport.

In order to study ITT, a lot of parameters are required. Examples of these are information on the location and capacity of the participating terminals, data regarding the infrastructure that connects the terminals, and technical characteristics like moving speed and handling times of the equipment, both vehicles and cranes, that can be used for the ITT.

So far, a set of the relevant ITT parameters and their values has not been made publicly available. This report proposes a basic set of parameters, their definitions, and proposed values required when studying ITT. The parameters proposed in this report are those encountered while carrying out the present ITT project mentioned above.

Carrying out an ITT design study is a highly complex, multidisciplinary task. Tasks that have to be implemented range from definition of demand scenarios, determination of ITT vehicle configurations, and evaluation of such configuration from various perspectives. When carrying out the research involved in each of these tasks, consistency regarding the meaning of parameters and their values is crucial in obtaining alignment of the outcomes. Figure 1 illustrates the ITT methodology and the relation among the different tasks proposed in the above mentioned project.

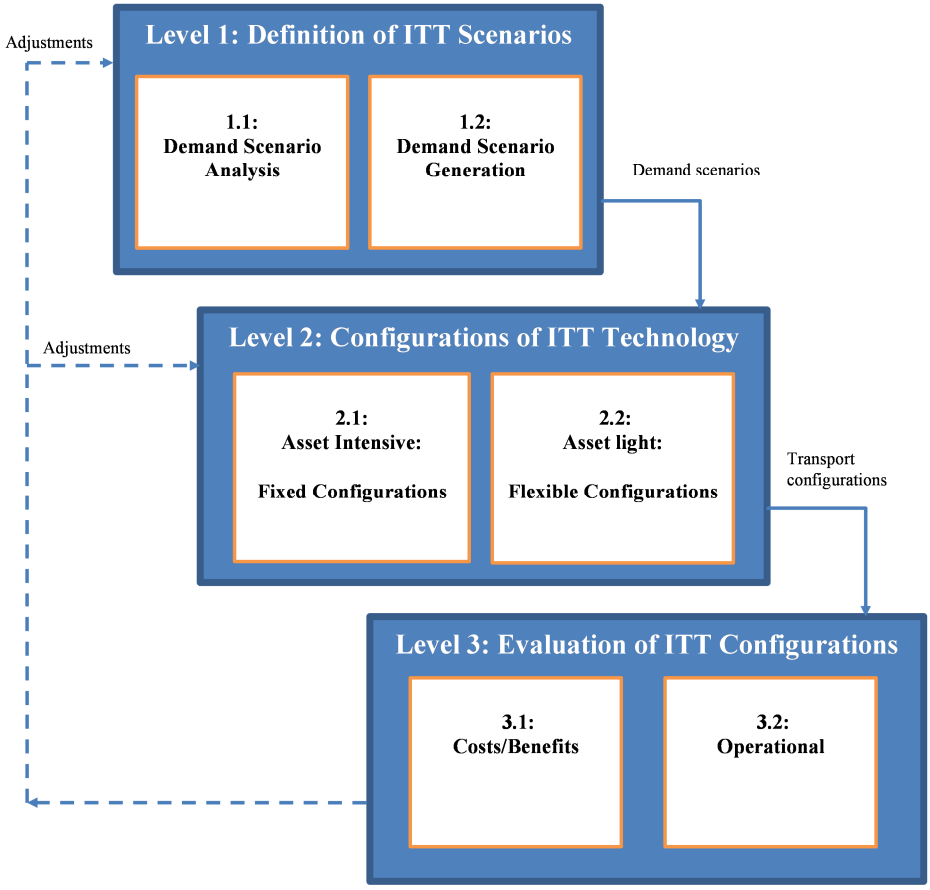

Figure 1 Overview of proposed methodology for ITT system design

A precise definition of common input parameters is required to guarantee that parameters and outcomes of experiments are interpreted by different researchers and research users in the same way. In order to be able to compare the outcomes of the various tasks involved in an ITT design process, it must be guaranteed that all the results are based on the same input values.

Making a data set of parameters commonly used by the implementation of each task explicit is not only needed for the alignment between the subprojects but is also of great value in the communication with the initiators of such a project. By showing the problem owners (port authority, terminal operators, etc.) the common parameter set that is the foundation of the implementation of the various tasks, they will gain insight in depth and breadth of the methodology followed. Moreover, it will enable the verification and validation of the values in the common parameter set, possibly leading to directions for further research regarding appropriateness of parameter values.

In this report the common parameters and their definitions as developed within the framework of the ITT project focused on the Port of Rotterdam Maasvlakte 1 and 2 area are presented, grouped into six sections:

2. Terminals
3. Intersections
4. Roads
5. Vehicles
6. Equipment
7. Container Demand

An extensive database has been created with verified values for the key parameters. These values can be found in the tables in each section and are available in electronic form upon request.

2 Terminals

ITT is concerned with the transport of containers between terminals. The terminals relevant in the Rotterdam area are the current and future terminals on the Maasvlakte 1 and 2, see Figure 2. Table 1 provides the definitions of parameters associated with the terminal information. Table 2 provides detailed parameter values.

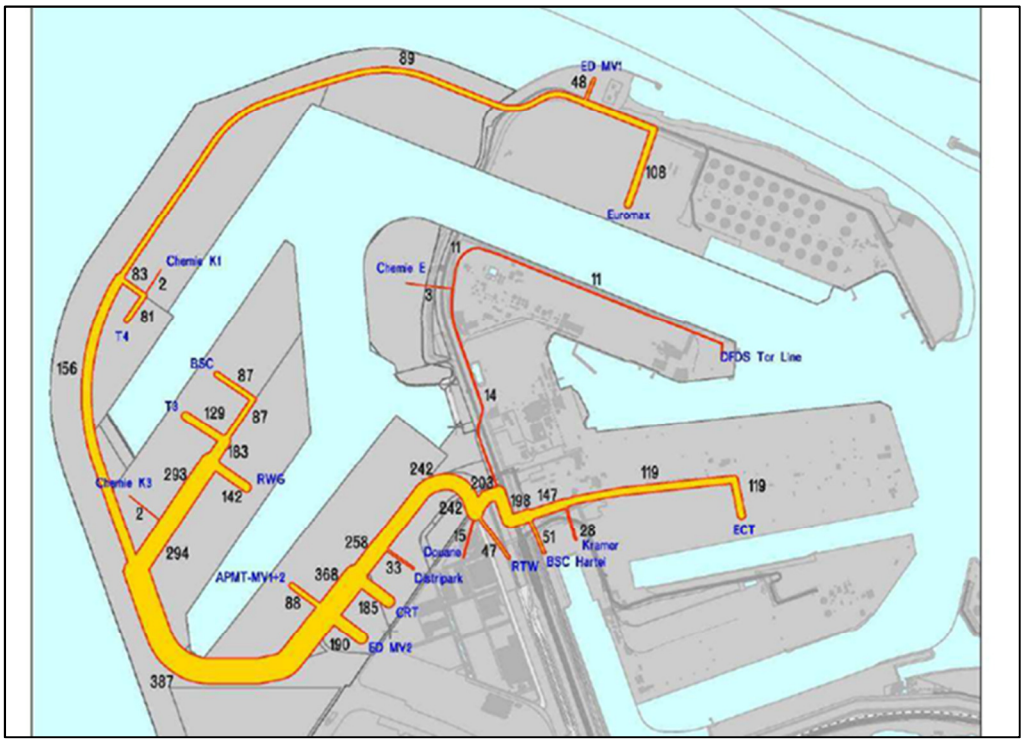

Figure 2 Overview of terminals at Maaasvlakte I and II

Table 1 Definition of Terminals

Parameter name	**Unit**	**Definition**
number	terminal number	identification number of the terminal
name	string	name of the terminal
player	string	name of the coalition that the terminal joins
backdoor connections	terminal number(s)	terminal(s) with a non-ITT connection (shortcut)
equipment	equipment type	type of handling equipment used for ITT
number of cranes	Integer	number of handling equipment used for ITT
number of QCs	integer	available QCs to handle ITT barges
year capacity	integer	maximum yearly throughput capacity of the terminal

Number	Terminal Name	Player	Backdoor connections (terminalnumbers)	Equipment (type)	# Equipment	# QC	Year Capacity (1000 TEU)
1	ECT Delta Terminal	ECT	3, 8, 12, 14	ASC	4	1	6912
2	Euromax Terminal	ECT	7	ASC	4	1	4544
3	APM MV1 Terminal	APM	8	ASC	3	1	2700
4	Rotterdam World Gateway	RWG		ASC	3	1	4215
5	APM MV2 Terminal	APM	10, 17	ASC	3	1	4860
6	T3	Player 6	4, 13	ASC	3	1	4223
7	T4	Player 6		ASC	3	1	794
8	ECT Delta Barge Feeder Terminal	ECT		SC	2	1	770
9	Delta Container Services	ECT		RS	2	1	68
10	Common Rail Terminal	Common services		SC	5	0	
11	Rail Terminal West	ECT		SC	6	1	
12	Barge Service Center Hartelhaven	Kramer		RS	4	1	500
13	Common Barge Service Center	Common services		SC	4	1	383
14	Kramer Delta depot	Kramer	9	RS	3	1	
15	Van Doorn Container depot	Kramer		RS	3	0	
16	Empty depot MV1	Kramer	2	RS	3	0	
17	Empty depot MV2	Kramer	10	RS	4	0	
18	Douane	Common services		RS	2	0	
19	Distripark						
20	DFDS / Rhenus lokatie						540

Table 2 Proposed terminal parameter values

3 Intersections

The ITT infrastructure is represented by a set of nodes and a set of arcs between the nodes. Nodes are the beginning or end of arcs and represent the locations of either the terminals or intersections. At the intersections, ITT vehicles (and possibly other terminal traffic) will interact and due to the limited capacity of the intersections, congestion can occur. Different strategies to control the capacity of an intersection can be defined.

Figure 3 presents an overview of the terminals and intersections, and the land roads that connects these nodes. In Figure 4 the waterways ('water roads') are given. The definitions for intersections are given in Table 3. Table 4 contains the detailed values related to intersections. the definitions for roads are given in the next section.

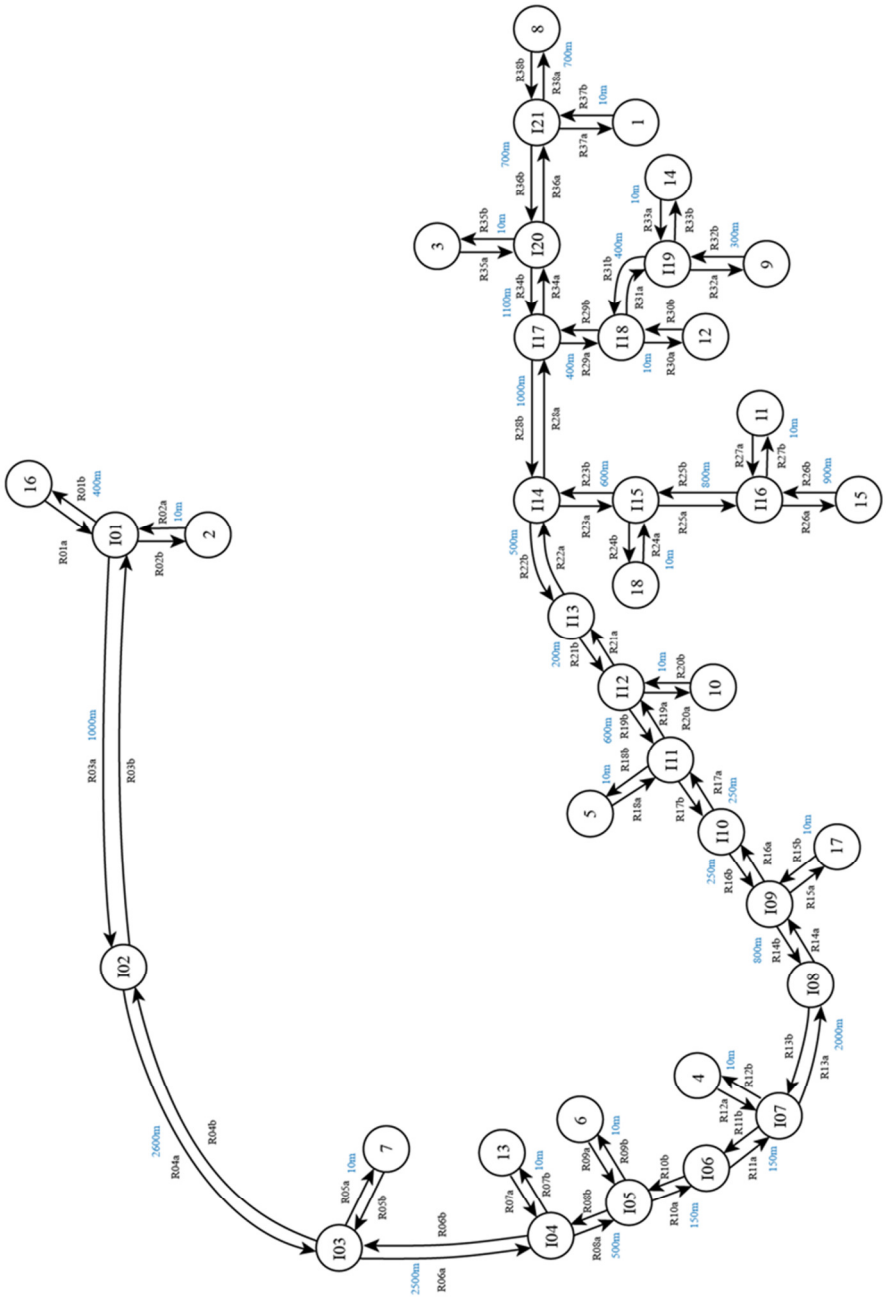

Figure 3 Overview of land roads considered by ITT.

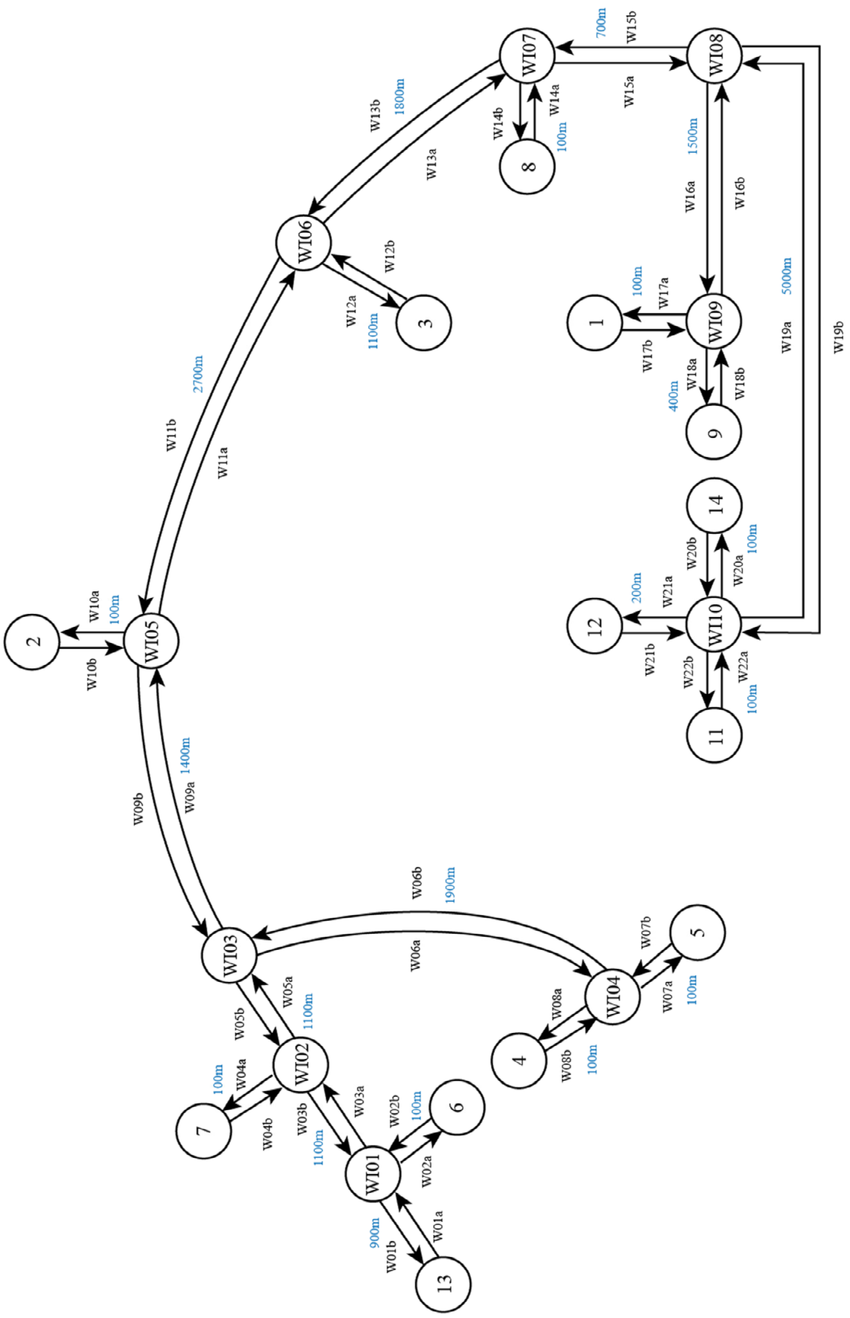

Figure 4 Overview of waterways considered for ITT.

Table 3 Definition of intersections

Parameter name	Unit	Definition
name	string	name of the intersection
type	intersection type	type of intersection: 3-way, 4-way, traffic-light or water
crossing time	second	time to cross the intersection for 1 standard vehicle unit
green light time	minute	time that the intersection is blocked for ITT
red light time	minute	time that the intersection is open for ITT
intersection capacity	#/minute	capacity of the intersection in flow model

Table 4 Proposed parameter values for intersections

Name	Type	Crossing Time (sec)	Greenlight Time (min)	Redlight Time (min)	Capacity (#/min)
I01	3-way	7.5	0	0	8
I02	traffic-light	0	18	2	8
I03	3-way	7.5	0	0	8
I04	3-way	7.5	0	0	8
I05	3-way	7.5	0	0	8
I06	traffic-light	0	18	2	8
I07	3-way	7.5	0	0	8
I08	traffic-light	0	18	2	8
I09	3-way	7.5	0	0	8
I10	traffic-light	0	18	2	8
I11	3-way	7.5	0	0	8
I12	3-way	7.5	0	0	8
I13	traffic-light	0	18	2	8
I14	3-way	7.5	0	0	8
I15	3-way	7.5	0	0	8
I16	3-way	7.5	0	0	8
I17	3-way	7.5	0	0	8
I18	3-way	7.5	0	0	8
I19	3-way	7.5	0	0	8
I20	3-way	7.5	0	0	8
I21	3-way	7.5	0	0	8
WI01	water	0	0	0	3
WI02	water	0	0	0	3
WI03	water	0	0	0	3
WI04	water	0	0	0	3
WI05	water	0	0	0	3
WI06	water	0	0	0	3
WI07	water	0	0	0	3
WI08	water	0	0	0	3
WI09	water	0	0	0	3
WI10	water	0	0	0	3

4 Roads

The arcs in the ITT network are the roads and waterways between the terminals used by the ITT vehicles. For each road, the begin and end node is given; a node is either a terminal or an intersection. The definition of intersections is given in Table 5.

Table 6 contains the detailed parameter values.

Table 5 Definition of roads

Parameter name	Unit	Definition
name	string	name of the road
type	road type	type of road: land or water
length	meter	length of the road
start node	terminal/intersection	starting terminal or intersection
start orientation	E, N, W, S	orientation of the vehicle at the starting node
end node	terminal/intersection	ending terminal or intersection
end orientation	E, N, W, S	orientation of the vehicle at the ending node

Table 6 Proposed parameter values for roads

Name	Type	Length (m)	Start Node (terminal/intersection)	Start Orientation (E, N, W, S, -)	End Node (terminal/intersection)	End Orientation (E, N, W, S, -)
R01a	land	400	16	-	I01	E
R01b	land	400	I01	E	16	-
R02a	land	10	2	-	I01	S
R02b	land	10	I01	S	2	-
R03a	land	1300	I01	W	I02	E
R03b	land	1300	I02	E	I01	W
R04a	land	2600	I02	W	I03	N
R04b	land	2600	I03	N	I02	W
R05a	land	10	7	-	I03	E
R05b	land	10	I03	E	7	-
R06a	land	2500	I03	S	I04	N
R06b	land	2500	I04	N	I03	S
R07a	land	10	13	-	I04	E
R07b	land	10	I04	E	13	-
R08a	land	500	I04	S	I05	N
R08b	land	500	I05	N	I04	S
R09a	land	10	6	-	I05	E
R09b	land	10	I05	E	6	-
R10a	land	150	I05	S	I06	W
R10b	land	150	I06	W	I05	S
R11a	land	150	I06	E	I07	W
R11a	land	150	I07	W	I06	E
R12a	land	10	4	-	I07	N
R12b	land	10	I07	N	4	-
R13a	land	2000	I07	E	I08	W
R13b	land	2000	I08	W	I07	E
R14a	land	800	I08	E	I09	W
R14b	land	800	I09	W	I08	E
R15a	land	10	I09	S	17	-
R15b	land	10	17	-	I09	S
R16a	land	250	I09	E	I10	W
R16b	land	250	I10	W	I09	E
R17a	land	250	I10	E	I11	W
R17b	land	250	I11	W	I10	E
R18a	land	10	5	-	I11	N
R18b	land	10	I11	N	5	-
R19a	land	600	I11	E	I12	W
R19b	land	600	I12	W	I11	E
R20a	land	10	I12	S	10	-
R20b	land	10	10	-	I12	S
R21a	land	200	I12	E	I13	W
R21b	land	200	I13	W	I12	E
R22a	land	500	I13	E	I14	W
R22a	land	500	I14	W	I13	E
R23a	land	600	I14	S	I15	N
R23b	land	600	I15	N	I14	S
R24a	land	10	18	-	I15	W

R24b	land	10	I15	W	18	-
R25a	land	800	I15	S	I16	N
R25b	land	800	I16	N	I15	S
R26a	land	900	I16	S	15	-
R26b	land	900	15	-	I16	S
R27a	land	10	11	-	I16	E
R27b	land	10	I16	E	11	-
R28a	land	1000	I14	E	I17	W
R28b	land	1000	I17	W	I14	E
R29a	land	400	I17	S	I18	N
R29b	land	400	I18	N	I17	S
R30a	land	10	I18	S	12	-
R30b	land	10	12	-	I18	S
R31a	land	400	I18	E	I19	N
R31b	land	400	I19	N	I18	E
R32a	land	300	I19	S	9	-
R32b	land	300	9	-	I19	S
R33a	land	10	I19	E	14	-
R33b	land	10	14	-	I19	E
R34a	land	1100	I17	E	I20	W
R34b	land	1100	I20	W	I17	E
R35a	land	10	I20	N	3	-
R35b	land	10	3	-	I20	N
R36a	land	700	I20	E	I21	W
R36b	land	700	I21	W	I20	E
R37a	land	10	I21	S	1	-
R37b	land	10	1	-	I21	S
R38a	land	700	I21	E	8	-
R38b	land	700	8	-	I21	E
W01a	water	900	13	-	WI01	W
W01b	water	900	WI01	W	13	-
W02a	water	100	WI01	S	6	-
W02b	water	100	6	-	WI01	S
W03a	water	1100	WI01	E	WI02	W
W03b	water	1100	WI02	W	WI01	E
W04a	water	100	WI02	N	7	-
W04b	water	100	7	-	WI02	N
W05a	water	1100	WI02	E	WI03	W
W05b	water	1100	WI03	W	WI02	E
W06a	water	1900	WI03	S	WI04	N
W06b	water	1900	WI04	N	WI03	S
W07a	water	100	WI04	E	5	-
W07b	water	100	5	-	WI04	E
W08a	water	100	WI04	W	4	-
W08b	water	100	4	-	WI04	W
W09a	water	1400	WI03	E	WI05	W
W09b	water	1400	WI05	W	WI03	E
W10a	water	100	WI05	N	2	-
W10b	water	100	2	-	WI05	N
W11a	water	2700	WI05	E	WI06	W
W11b	water	2700	WI06	W	WI05	E
W12a	water	1100	WI06	S	3	-
W12b	water	1100	3	-	WI06	S
W13a	water	1800	WI06	E	WI07	N
W13b	water	1800	WI07	N	WI06	E
W14a	water	100	WI07	W	8	-
W14b	water	100	8	-	WI07	W
W15a	water	700	WI07	S	WI08	N
W15b	water	700	WI08	N	WI07	S
W16a	water	1500	WI08	W	WI09	E
W16b	water	1500	WI09	E	WI08	W
W17a	water	100	WI09	N	1	-
W17b	water	100	1	-	WI09	N
W18a	water	400	WI09	W	9	-
W18b	water	400	9	-	WI09	W
W19a	water	5000	WI08	S	WI10	S
W19b	water	5000	WI10	S	WI08	S
W20a	water	100	WI10	E	14	-
W20b	water	100	14	-	WI10	E
W21a	water	200	WI10	N	12	-
W21b	water	200	12	-	WI10	N
W22a	water	100	11	-	WI10	W
W22b	water	100	WI10	W	11	-

5 Vehicles

For the ITT study, multiple types of vehicles are studied. Automated and manned vehicles, single and multiple container loads, self-loading or crane-handled are all under consideration. Parameters of the vehicles are defined in Table 7. Table 8 contains the proposed parameter values.

Table 7 Definition of vehicles

Parameter name	**Unit**	**Definition**
name	string	name of the (type of) ITT vehicle
capacity	integer	capacity in TEU
manned	boolean	human driver required for vehicle
average speed	kilometer/hour	average speed of vehicle for ITT distances
length	meter	length of vehicle
purchase costs	euro	purchase costs of vehicle
fixed costs	euro	fixed costs per year
wage costs	euro/hour	driver wage costs per hour
fuel costs	euro/kilometer	fuel costs per kilometer
penalty costs	euro/hour	penalty costs per hour
mooring time	hour	required time for mooring (barge) or coupling (MTS trailer)
crossing factor	real	multiplier for standard intersection crossing time

Table 8 Proposed parameters for vehicles

Name	Capacity (TEU)	Manned	Avg. speed (km/hr)	Length (m)	Purchase costs (euro)	Fixed costs (euro)	Wage costs (euro/hr)	Fuel costs (euro/km)	Penalty costs (euro/hr)	Mooring time (min)	Crossing Factor
Truck (= TT)	2	Yes	40	17	97000	42783	25	0.250	15	0	1
MTS	10	Yes	30	82.5	290000	73500	25	0.375	15	0.5	2.67
AGV	2	No	40	15	340000	74000	0	0.250	15	0	1
ALV	2	No	40	13.7	500000					0	1
Barge	50	Yes	12		2500000					30	n.a.

6 Equipment

ITT equipment is used for the loading and unloading of ITT vehicles. Definition of the equipment is given in Table 9. Parameter values considered are found in Table 10.

Table 9 Definition of equipment

Parameter name	Unit	Definition
name	string	name
unload time	minute	time for unloading container from ITT vehicle
load time	minute	time for loading container to ITT vehicle
handling capacity	containers/hour	capacity of the crane in flow model

Table 10 Proposed parameter values for vehicles

Name	Unload Time (min)	Load Time (min)	Capacity (#/hour)
ASC	3	3	35
Straddle Carrier	4	4	35
Reachstacker	4	4	35
Quay Crane	3	3	2x30
ALV	0.5	0.5	n.a.

7 Container demand

Container demand is defined as interface between the demand scenario's that are developed at a scenario definition level and the models on the ITT vehicle configuration and configuration evaluation levels (see Figure 1). A demand generator will create scenarios in the form of a lists of containers that must be transported by ITT. Origin and destination terminals and the required time windows are hereby given. The list of containers is the input for all configuration and evaluation models and is the result of the demand generator according to some user-specified scenario.

The definitions for container demands are presented in Table 11. Table 12 contains an example of values for the specified parameters.

Table 11 Definition of container demand

Parameter name	Unit	Definition
start time	hour	arrival time
origin	terminal number	arrival terminal
delivery time	hour	departure time
destination	terminal number	departure terminal
TEU	integer	size of container in TEU (1 or 2)
arrival batch id	integer	identification number for a group of containers with the same arrival time and terminal
departure batch id	integer	identification number for a group of containers with the same departure time and terminal

Table 12 Example of values for demand parameters

Start Time (hour)	**Origin** (terminal)	**Delivery Time** (hour)	**Destination** (terminal)	**TEU** (1 or 2)
34.9717	4	40.8089	12	2
34.9805	13	39.5242	3	2
34.9846	15	43.8167	12	2
...	...	...	...	...

EXAMPLE DATA

8 Concluding remarks

This report has presented an overview of key parameters when studying ITT systems. In this case, the parameters presented are those encountered when implementing a methodology for ITT system design for the port of Rotterdam.

The database with parameter values is available in digital form upon request from the authors. The nomenclature and values in this database have already been used for implementing the various tasks in one ITT project. The parameters and values will also be a valuable starting point for future ITT investigations, especially those focusing on ITT related topics for the port of Rotterdam.

The current version of the database is not considered as an end product. It has been established keeping in mind that it should be possible to also incorporate new developments regarding parameter values in this database. New projects should be able to start from the most up-to-date version of the parameter database, rather than each time starting from scratch with new definitions and parameter value estimates.