CARGO TRANSPORT TIME LOSS AND DIESEL LOSS AT CORRIDORS AND INSIDE CARGO TERMINALS

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This Baltic Loop subreport summarizes aboservations about the delays emerged from bottlenecks and fuel consumption. The observations are based on detailed fieldwork including test driving and digital time-space data collection at cargo terminal. The time loss calculations are based on mapping of 28 (from Naantali port 25) bottlenecks. Bottleneck means that the truck has to stop or reduce its speed. The extent of slow down was documented by four test driving through the corridor Turku-Vaalimaa Border Cross Station.

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Gateway

The calculations are based on standardized consumption of diesel operated trucks and C02 emissions associated to these comsumption figures. Individual variations exist but the figures shown here represent average resuts for one truck of 48 000 tons size. The journey included the standard and legislative stops and avarege two visits to terminals.

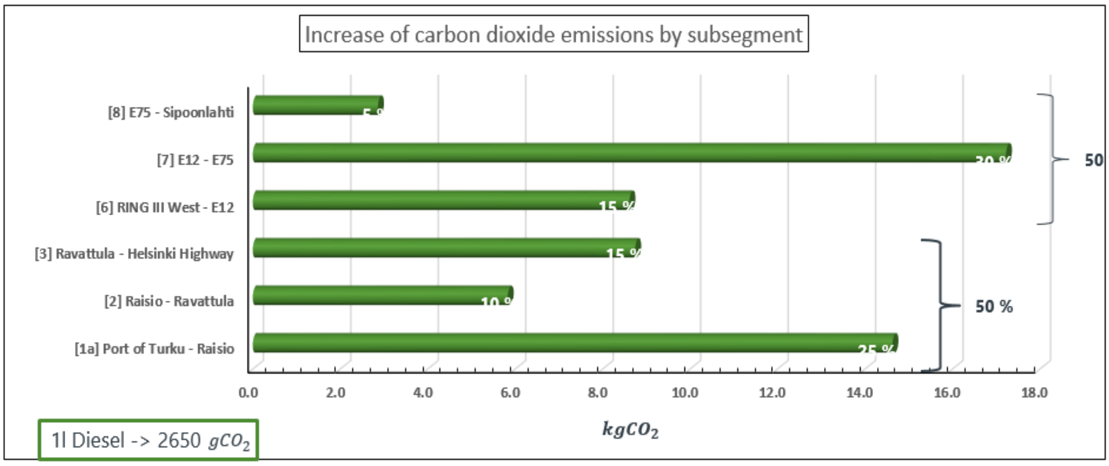
Table 1. The number of observed bottlenecks along the corridor, number of bottlenecks and diesel loss and emissions due to bottlenecks.

Segment	Length (km)	Time (h)	Avg. Speed (km/h)	Number of bottlenecks	Total time loss (min)	Total diesel loss (l)	Total produced emissions ($kgCO_2$)
Turku - Vaalimaa	367	5,49	66,8	28	6,4	22	58
Naantali - Vaalimaa	368	5,44	67,7	25	5,2	20	53
Turku Center - Vaalimaa	353	5,17	68,2	23	2,9	16	42

The figure shows the 42kg to 58 kg CO2 emissions of one 48 000 tons truck along the gateway. Because of bottleneck the present extra time loss for one truck is averagely around 6,4 minutes and the extra diesel consumption is around 20 liters for one truck.

Thus one 48 000-ton truck is producing the 58 kgs of extra C02 emissions for the whole journey. The extra emissions are mainly concentrated on six segments (*see* table 2).

Table 2. Increase of C02 emissions due the gateway bottlenecks. Most of the emissions originate from segments of urban environments and from segments of road construction works. they can be classified as temporary.



The most important segments are Helsinki capital area Ring Road III, whereas the E-18 lays in the middle of urban structure with numerous intersections; These segment soccer 35 % of all emissions of C02. The segment from Turku airport to Raisio town is remarkable for emissions as well; 25 % of all emissions and it is also due the urban structure and associated slow driving.

Figure 1 shows the time losses in seconds linked to urban area and Turku Ring Road; first three segments from Turku port.

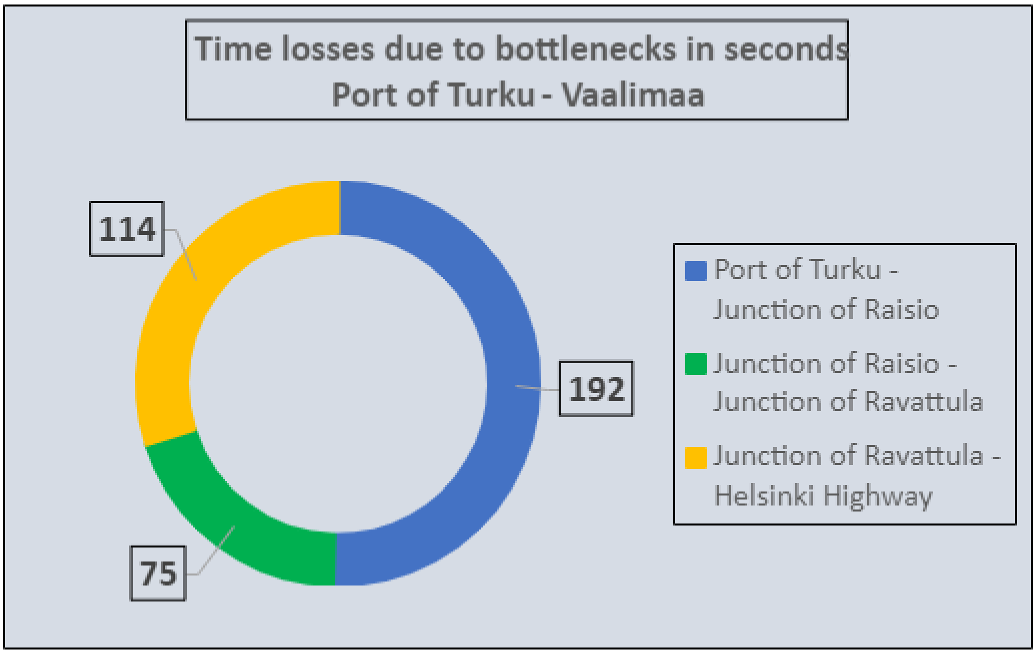


Figure 1. The time losses of first three segments from Turku to the west. Due to road repairing and existing urban structure the delays in cargo traffic are indicative.

We calculated that the increase of C02 emissions due the bottlenecks were calculated based on assumptions of 48 000-ton standard truck and with daily average 2600 trucks driving throughout the E-18 gateway. On daily basis the total increase of emissions due the bottleneck is 150 800 kgs and yearly increase is 550042000 kgs for trucks *i.e.,* 550042,00 tons.

It should be noticed that there are strong variations in the size of trucks and the figure just present the average situations. Moreover, the geographical variations exits heavy vehicle traffic is concentrating on capital area and near Turku-Naantali port segments.

Inside cargo terminals

Baltic Loop project study the bottlenecks inside the cargo terminal by using data collection methodology of being developed by Noccela ltd. The monitoring devices were installed on all the machines in the terminal and in addition the tags were attached to the pallets arriving at the terminal. A total of 70 tags were used. Noccela uses the Ultra-Wide Band (UWB) as its technology and its own High-performance Ranging (HRP) positioning method. The anchors use tags to collect the information and send this information to the cloud, where the actual calculation and analysis is performed.

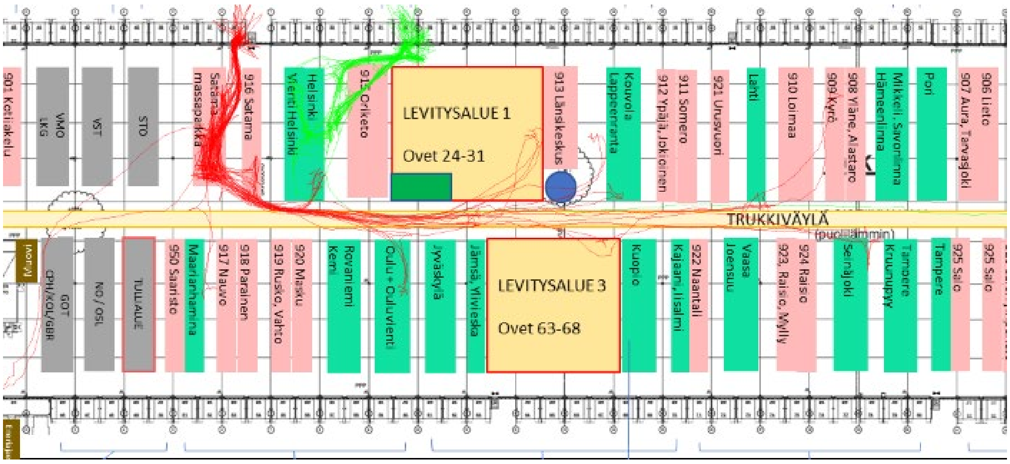
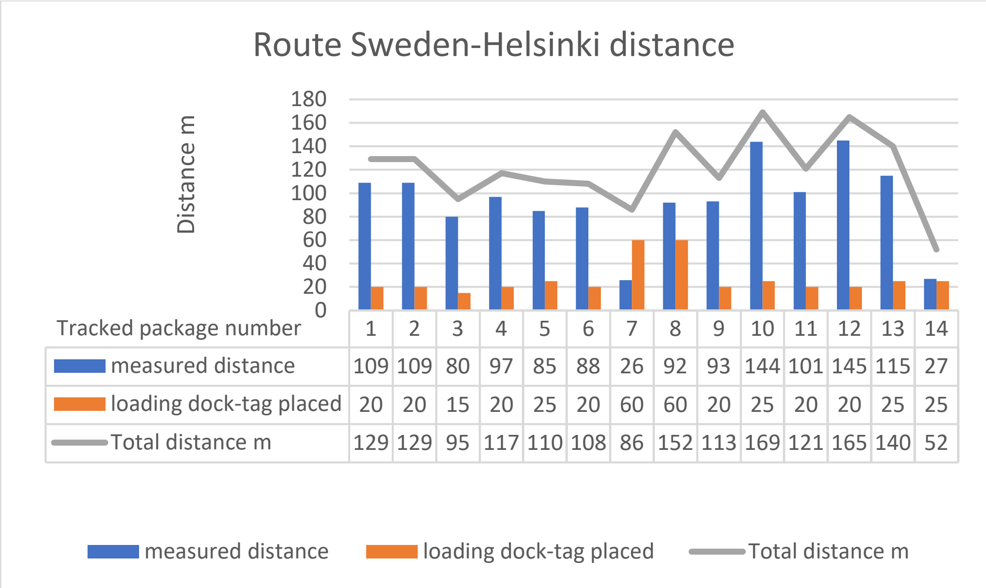


Figure 2. Red movements of the pressing machine used for unloading, loading and sorting. The movements of a forklift used for the same purpose in green. data collected with UWB system.

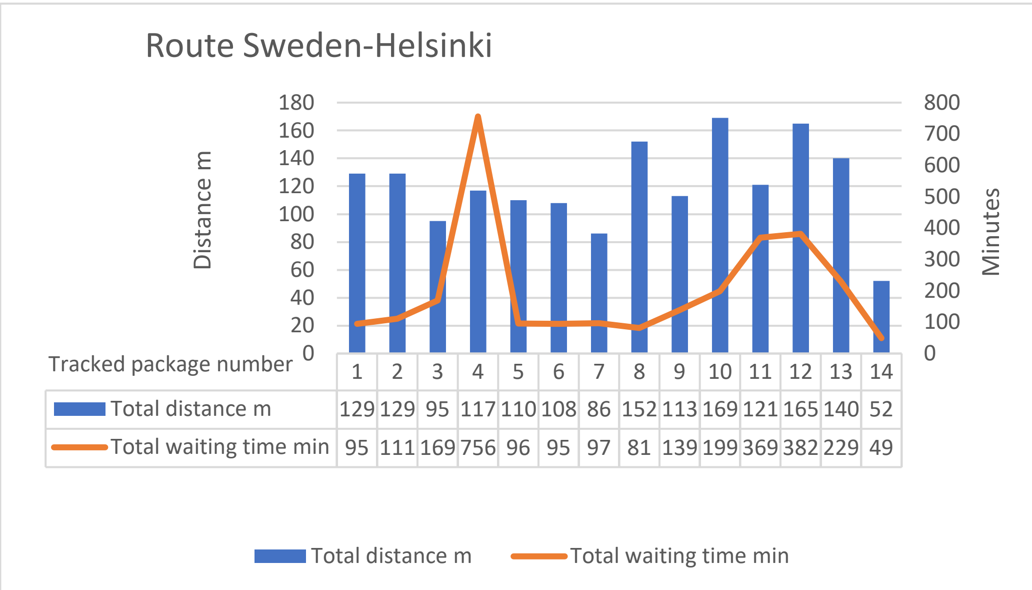
The terminal size is 14,000 m2 in, in addition to which there is 3,300 m2 of unheated storage for long and heavy goods. In addition, there is a 500-m2 wing for loading vans. There is also a 50m long line for sorting packages with a capacity of 4,500 packages per hour. There are 106 loading doors in the terminal. There are 41 electronic load-handling devices in the DB Schenker terminal. Of these, 20 are counterbalanced forklifts; there are two pallet trucks for moving two pallets, 4 pallet trucks for moving one pallet, 11 pallet trucks for walking, two stackers and two pick-up trucks. speeding up the lead times of the goods in the terminal area. Accelerating the transit time of goods at the terminal will increase the efficiency of the use of working time and the terminal will be able to handle larger volumes. Figure 3 (*see* below) shows as an example the measured distance from one selected route (Sweden-Helsinki).



Tracked package number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
measured distance	109	109	80	97	85	88	26	92	93	144	101	145	115	27
loading dock-tag placed	20	20	15	20	25	20	60	60	20	25	20	20	25	25
Total distance m	129	129	95	117	110	108	86	152	113	169	121	165	140	52

Figure 3. Example form measured distances from selected route. Total distance transferred inside terminal was 120 m.

Figure 4 shows the whole period inside terminal in selected route between Sweden and Helsinki.



Tracked package number	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total distance m	129	129	95	117	110	108	86	152	113	169	121	165	140	52
Total waiting time min	95	111	169	756	96	95	97	81	139	199	369	382	229	49

Figure 4. Time phase inside terminal. The average stay onside terminal was 124 m with wide range between 6 to 614 minutes.

Conclusions

The study suggested four improvements in terminal logistic operations. If these suggestions being presented in detail (Väisänen 2021) are put into practice. The time saving inside terminal is 0,17 to 3 minutes per parcel. This refers to total daily savings of 1190 minutes (around 20 hours of work) with the average amount of 7000 parcel. This extra time can be used to speed up the leaving of truck and/or increase the throughflow capacity of cargo. There are also need for further research linking to automatization of cargo handling and rearrangement of terminal building layout and more precise internal transfer movements of cargo.

The study revealed remarkable time saving possibilities both on the gateway and in terminal operations. These savings have remarkable input on gasoline savings and emissions as well.

References

Väisänen, A. (2021). Improving the internal logistics of cargo terminal. Unpublished BSc-thesis work, Turku University of Applied Science, 38p.

Appendix1: Data for emission calculations

Appendix 2: Calculations are based on truck with total mass 48 000 kgs and 76 000 kgs and associated average diesel consumption.

Kokonaismassa 48 000 kg, 360 kW (490 hv)

Kiihdytykset

km/h	sekuntia	km	litraa	l/100 km
0-40	13	0,10	0,28	280
0-50	20	0,20	0,45	230
0-60	31	0,35	0,67	195
0-70	43	0,57	1,0	170
0-80	60	0,92	1,3	145

Vakionopeudet

km/h	l/100 km
40	30
50	32
60	35
70	38
80	41
90	45
100	50

Kokonaismassa 76 000 kg, 480 kW (650 hv)

Kiihdytykset

km/h	sekuntia	km	litraa	l/100 km
0-40	16	0,12	0,46	375
0-50	26	0,24	0,74	305
0-60	38	0,44	1,1	255
0-70	54	0,72	1,6	220
0-80	75	1,2	2,2	190

Vakionopeudet

km/h	l/100 km
40	45
50	47
60	50
70	53
80	57
90	61
100	65

Appendix 3. Standard calculations for CO2 and CO emissions for different average diesel consumption.

Raskaiden ajoneuvojen tyyppihyväksyntäpäästöarvojen (g/kWh) likimääräinen laskenta yksikköön g/km polttoaineenkulutuksen perusteella

raja-arvot (transient test)													
CO	4,0	g/kWh	CO		Kulutus l/100 km								
THC	0,16	g/kWh	THC		10	15	20	25	30	35	40	45	50
NOx	0,46	g/kWh	NOx	CO_2 g/km	265	398	530	663	795	928	1060	1193	1325
PM	0,01	g/kWh	PM										
				CO g/km	1,0	1,5	2,0	2,5	3,0	3,5	4,0	4,5	5,0