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Cross-dock optimisation

GEFCO Braine L'Alleud

2018

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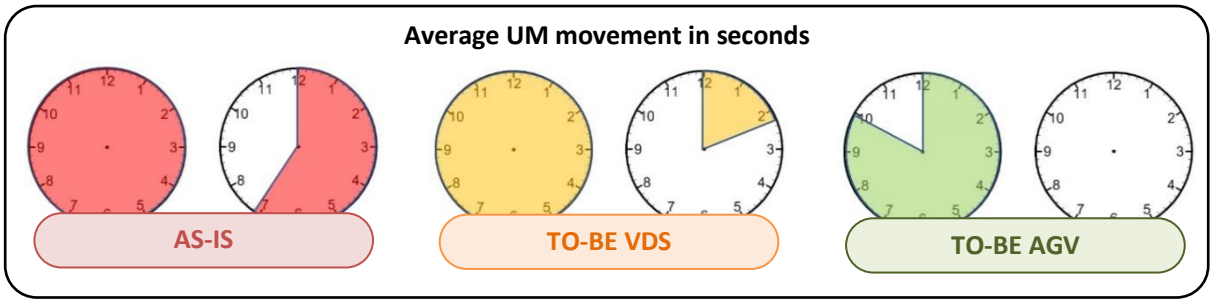
1 INTRODUCTION

At the start of the business game, we analysed the data given from GEFCO very thoroughly. Then we went back to the basics to find solutions for the **4 main aspects**. We were able to re-implement the given data in our solution which gave us realistic results and conclusions.

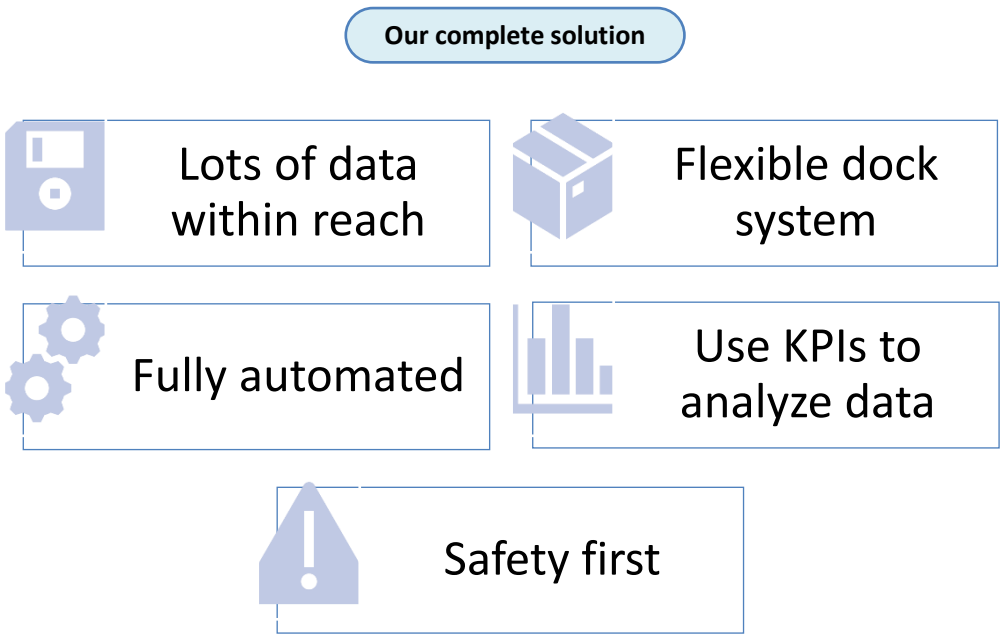
The core of our entire solution starts with data. Sufficient data is required to make good decisions. We will be setting up a data platform to empower our business with clear **communications** throughout GEFCO's supply chain. This will be the input of the internal logistics.

The seconds aspect and probably to most important one is the **optimisation** of the cross-dock operations. Tackling peak moments and bottle necks of the **physical handling** with flexibility will be our focus. We offer you two options. A quick win, an easy implementation to increase efficiency and the productivity of the cross-dock operations. A second state-of-the-art high-tech solution, which will be a fully automated cross-dock on top of the first quick win, will further improve the operations. The following illustration gives you an idea of the impact on our time savings, "Time Is money!".



We will encourage you to implement lean improvement tools to further grow your business. The new data that is being collected can be used to set up KPI's to help you with a sustainable continuous improvement culture. Lastly we will handle the on-site **safety and security** at GEFCO Braine L'Alleud and the **communication with the drivers**.

A much higher **attractiveness** towards partners and employees will be the consequence of all our efforts.



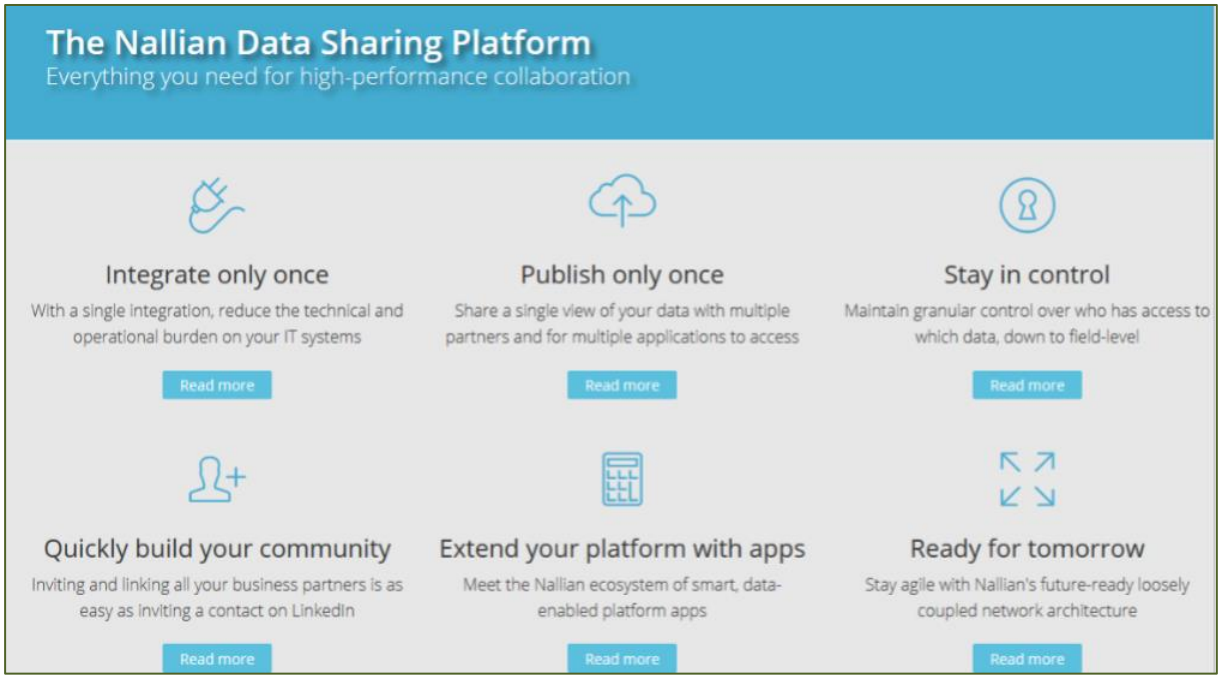
2 Supply Chain Communication Improvements

2.1 Goal

Our preferred warehouse solution starts from an entirely new way of communicating with suppliers and subcontractors. Our idea is to implement a data sharing platform using blockchain. This is **key** to improving the entire process within GEFCO and its supply chain.

A **data sharing platform** facilitates sharing data with subcontractors and suppliers.

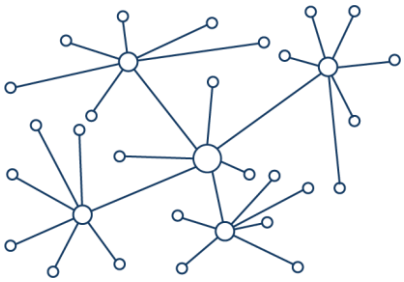
"What about security?", "How can we guarantee data safety data?". A data sharing platform based on **blockchain** ensures complete control on data access: you decide who can access what data. An example of such data platform is **Nallian** (used for BRUCargo, NxtPort Antwerp…).



2.2 View on data-sharing within the GEFCO-case

- GEFCO starts its data sharing platform
- Shares its data with suppliers and subcontractors
- Supplier
  - Inputs order information
  - Can consult order status
  - Track & Trace (through scanning)
- Subcontractor
  - Platform with available routes (based on input order information)
  - Time slots

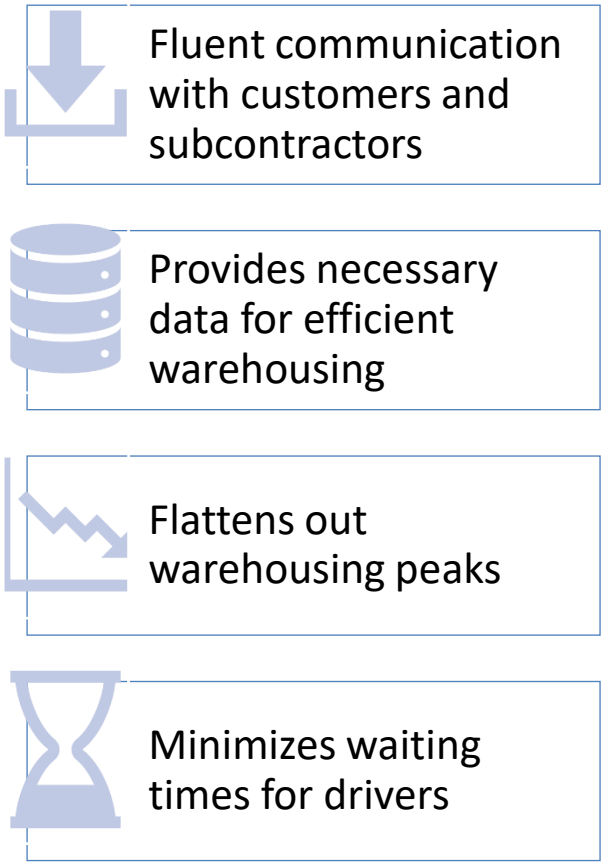
In an ideal world, if every company starts sharing data using a data-sharing platform, which creates networks of supplier, distributer, customers etc. These are called **supply networks**. We think it's necessary that companies today view themselves as parts of larger units – a supply chain, or even a supply network – in order to be as efficient as possible.



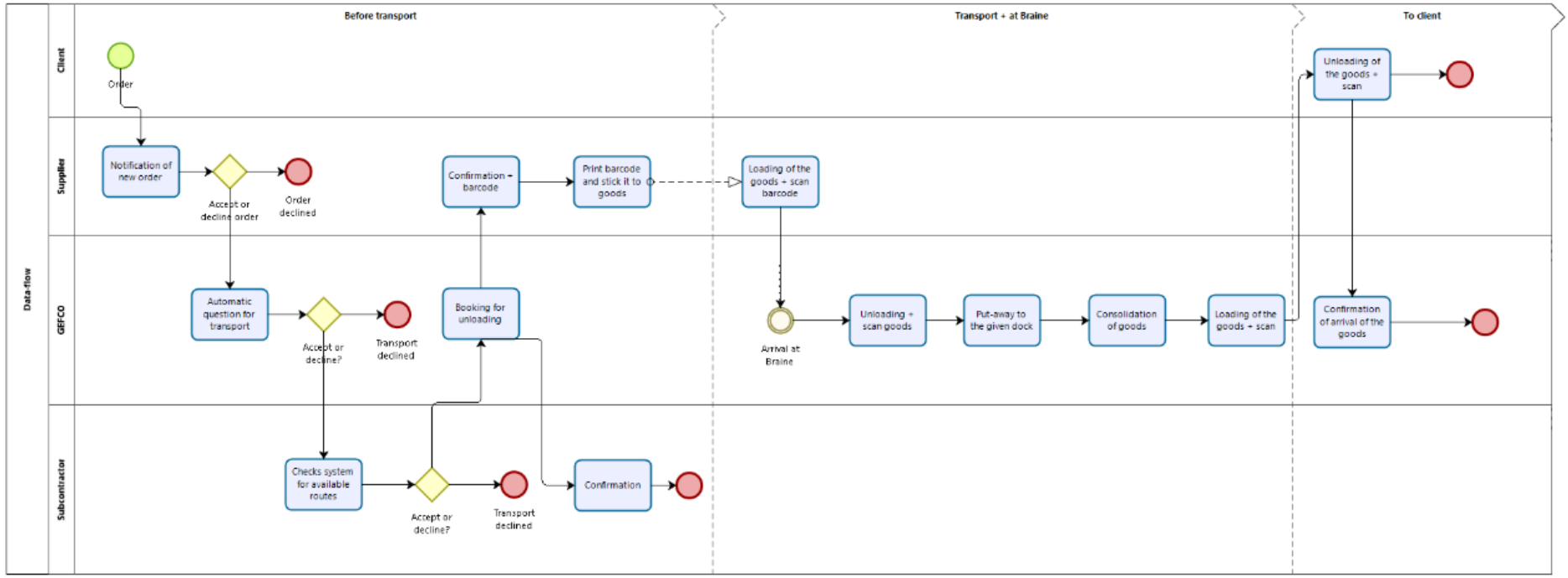
As GEFCO has many different branches, this could be a solution for the entire GEFCO network. This system allows for goods to be tracked throughout their handling cycle within the GEFCO group. The case data teaches us that data-collection stops when goods are delivered to the following GEFCO-depot. We regret this, as delivery lead times cannot be found this way. Again, more (accurate) data allows for better future decisions.

The following page shows a chart of the data-flow through the process. In short, we have implemented a shared data platform and data is shared with suppliers and subcontractors.

2.3 Possible advantages of shared data platform



2.4 Data-flow using shared data platform



2.5 Order simulation

2.5.1 Preceding transport

➔ **Supplier receives an order.**

In case the supplier adds his client to the shared data platform, the supplier gets notified of this new order.

➔ **Order and extra information are entered into the data-platform.**

The order must include all specifics about the goods (weight, volume, time and place of loading, pallet? oversized?).

This step will be very important in the later process and key to our solution!!

➔ **GEFCO automatically receives a question for transport.**

If GEFCO accepts, the order specifics are loaded onto the platform for subcontractors and all subcontractors can see which orders need to be executed.

The subcontractor decides which orders to execute and accepts the order.

➔ **Timeslot booking**

When accepting the order, the subcontractor books a timeslot for unloading at GEFCO Braine L'Alleud. This will make sure that we can manage the peaks for the warehouse.

➔ **Confirmation of execution**

When all these steps are completed, GEFCO will get a notification and the supplier receives a confirmation of execution and a barcode. This barcode should be attached to the goods to-be-shipped. The subcontractor will also get a confirmation with a reference number. This reference number will be necessary when arriving at Braine so that the driver can open the gate.

➔ **When the goods are being loaded, the driver must scan the barcode on them.**

2.5.2 At Braine

➔ **Real-time timetable: arrival at Braine**

When the driver arrives at Braine, he sees a real-time timetable with the planned (un)loading times for each vehicle along with the assigned dock number. At the designated time, the driver can access the site and go to his dock. If not, he should wait in the assigned waiting area.

Figure 1 Time table

At the gate, next to the sign with safety precautions, we would put a real-time timetable where the driver can follow the (un)loading schedule. We use the round numbers, destination, dock number and scheduled (un)loading time – which will be adapted in case of delay.

This way, drivers will know exactly at what time they are scheduled to load or unload their truck.

Round N°	Destination	Scheduled (un)loading	Delay	Dock
12345678	BE2200 – 2400	6h15		21
98765432	BE7060 – 7100	6h15	+20min	10
23456789	BE2800 – 2500	6h20		17
87654321	BE1300 – 3090	6h20		5
76543219	BE7060 – 7100	6h30	+10min	57

➔ **Inbound scan + put away**

When the goods are unloaded and put on the inbound dock, they must be scanned. When they are next being put away, the employee scans them again and thus gets notified of the designated dock (number)

➔ **Put-away scan:**

When the goods have been put away, they must - again – be scanned, as should the barcode on the dock. In case of an error (wrong dock), a notification will appear on the scanner.

➔ **Consolidation:**

The goods are organized per route. All goods for a particular route are put in the right order on the dock. When the outbound truck arrives, the warehouse employees should merely move between dock and truck.

➔ **Outbound scan:**

When leaving Braine, the shipped goods are being scanned.

2.5.3 Delivery

➔ When arriving at the customer site, the driver must scan the goods.
➔ Confirmation of delivery
➔ When the goods are delivered, this will be visible in the system.

Throughout the entire process the customer can **trace** the order thanks to the scans that are made along the way.

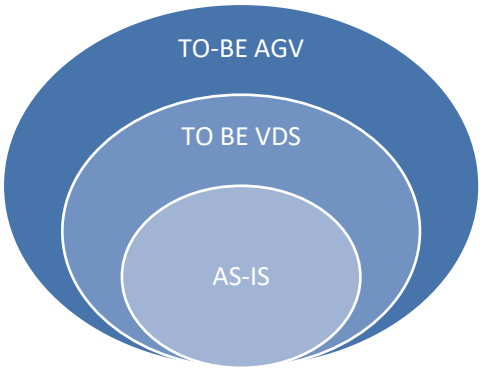
2.6 Conclusion

Our entire solution is built upon the implementation of a **data sharing platform**. This will provide the data that we need to efficiently allocate the UM's to the optimal dock-lane per route in the warehouse. On top of this the data platform will improve the **communication** between all parties in the supply chain and make it more pleasant for the driver.

3 Cross-dock Optimisation: Quick Win

3.1 Quick win goal

In order to increase **productivity** and **efficiency** in the cross-dock, a closer look should be taken at the driving and walking distances of internal logistics. To optimise cross-dock activities we will create an automated **Variable Dock-lane System (VDS)**, which will eliminate bottlenecks and unnecessary costs. The benefits of the Variable Dock-lane System will be shown through a simulation of the AS-IS and the TO-BE: VDS.



The TO-BE VDS requires only a minimum investment with no changes to any gate location or construction of the current cross-dock (AS-IS). This allows you to start the implementation immediately.

Once we've convinced you of the Variable Dock-lane System, we will introduce the high-tech solution for the ultimate experience. This will be called the TO-BE AGV.

Figure 2 Implementation

3.2 Variable Dock-lane System (VDS)

Figure 3 TO-BE VDS: Explanation structure

We will explain the VDS with the structure displayed in figure 2 above. To quickly give you an idea of the concept, the following 2 figures will illustrate the transition of the AS-IS to the TO-BE: Variable Dock-lane System.

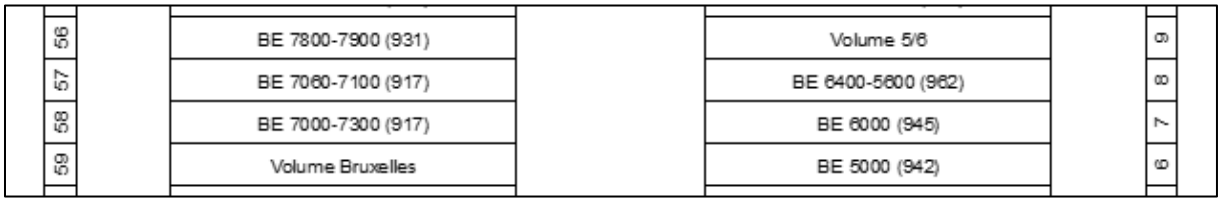


Figure 4 AS-IS with fixed zones

Figure 3 shows a part of the current AS-IS warehouse map. Here we see **fixed zone and route locations**. Regardless what merchandise must be loaded or unloaded, it will always be put in the same location.

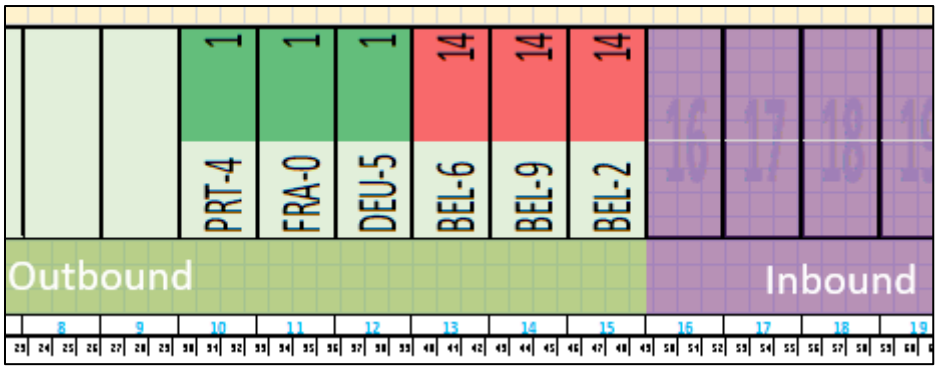


Figure 5 Variable Dock-lane System Sample

With the TO-BE VDS we created a solution with **variable locations** to minimise the number of movements, differing every day. We call it the Variable Dock-lane System. Example: today all merchandise for route 917 could be on dock 14, while tomorrow all merchandise for the same route could be on dock 60. Our automated system will inform the operator where to put the goods.

3.3 Data for simulation

Figure 6 TO-BE VDS: Data

3.3.1 Electronic Data Interchange

To achieve this variable cross-docking system, early incoming data from customers (suppliers, drivers…) will be analysed through real-time communication with **EDI** of a data sharing platform as mentioned earlier. After pre-receiving all orders for the day, the WMS system can allocate the incoming goods of that day to the proper dock-lane for later loading. We want the same useful data for outgoing orders.

3.3.2 Generating the scope data

In order to simulate the workflow, the **scope of the data** should be defined. We will use the given data of Appendix1 for all incoming merchandise based on the actual removal date **07/06/2018**. Next, destinations are considered and merchandise gets grouped accordingly. In real life, grouping would happen with **Smart Routes**.

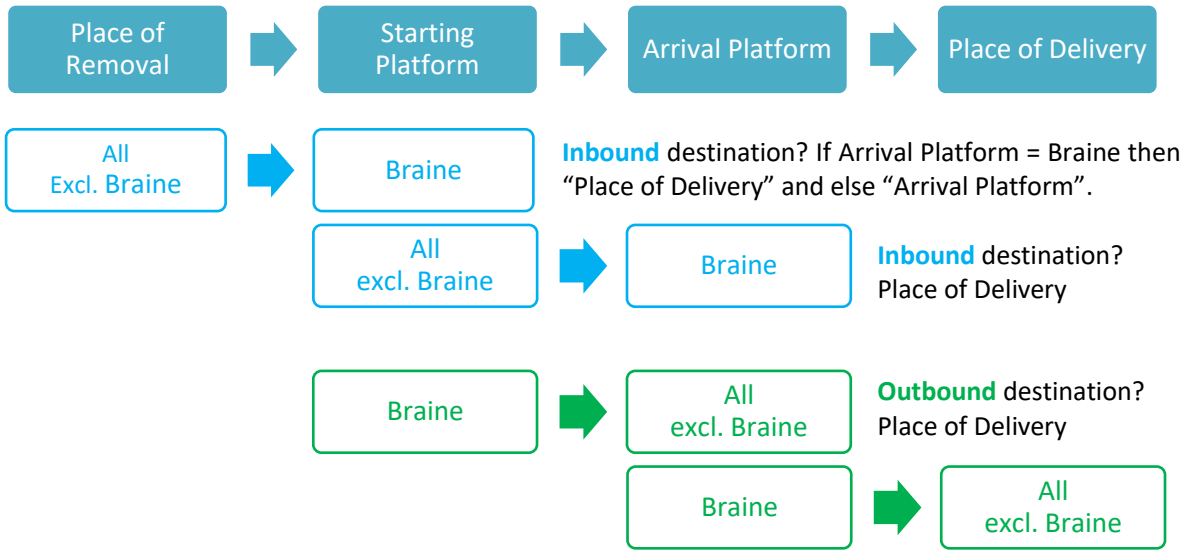
- *The incoming merchandise includes both incoming Starting Platform orders and incoming Arrival Platform orders.*
- *We use the removal date because we don't have the actual arrival times to GEFCO Braine. "D/H scheduled removal" in excel file seems to be an incorrect title. The correct title should be "Actual removal". We will be working with this time frame.*

3.3.2.1 Where and how do we get the destinations?

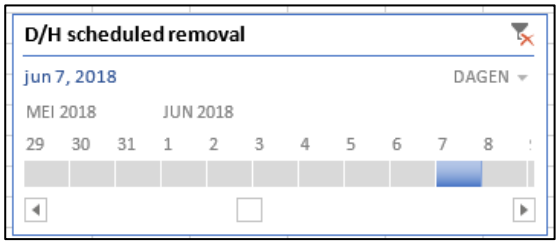
File: Appendix 1.xlsx

File: Crossdocking 5 scope.xlsx

Merchandise flow:



1. First we filter all the data on 1 date, leaving us with all trucks arriving on that day (in real life, you get this data real-time). We use the actual removal date ("D/H scheduled removal" in excel file) **07/06/2018**.



2. Find all the **Removals** (excl. Braine) that go to Braine Starting Platform
    a. Filter: Place of Removal: Take Braine out
    b. Filter: Starting Platform: Braine only
    c. Select this data and turn it into a pivot to find the **sum of UM's** per destination (movements for the ABC analysis).
    d. Destinations can be 2 options
        i. If Arrival Platform = Braine then the destination is the Place of Delivery
        ii. And else the destination is the Arrival Platform
        iii. Use for each option a pivot
3. Next are all the rides from all **Starting Platforms** (excl. Braine) that end in the Arrival Platform Braine
    a. Filter: Starting Platform: Take Braine Out
    b. Filter: Arrival Platform: Braine only
    c. Select this data and turn it into a pivot to find the **sum of UM's** per destination (movements for the ABC analysis).
    d. The destination is here always Place of Delivery
4. These are all the **UM's per destination** of all incoming merchandise on that day (inbound). We can now simulate groupage to their zone (or route).

After determining the necessary movements (table above), the data can be analysed and put into the simulator.

1. **Simplified postal code grouping will be used**. For example "BEL-3300" becomes "BEL-3". All destinations to "BEL-3" will be grouped together because of the label allotted by this **algorithm**. Destinations like "26BLANC BLANC 26" will be given the TBA label because we don't know the address.
2. The result is 152 destinations and 420 UM's to be moved, after consolidation we have **16 zones with 207 UM**. The remaining 213 TBA UM's will not take part in these simulations.
3. We can now easily analyse this data and **allocate dock-lanes.**

The outbound calculations are similar, even easier. The destinations are immediately visible because the data starts from Braine (see above).

3.3.2.2 Generated scope data

Rijlabels	Som van UM	Som van LM
TBA	213	18,14
BEL-1	40	5,20
BEL-8	38	6,35
BEL-2	34	6,87
BEL-9	30	9,85
BEL-7	25	3,67
BEL-6	14	1,56
BEL-4	10	0,12
BEL-3	5	0,18
BEL-5	4	0,27
DEU-5	1	0,25
DEU-8	1	0,25
DNK-8	1	0,25
FRA-0	1	0,11
FRA-5	1	0,80
FRA-9	1	0,29
PRT-4	1	0,25
Eindtotaal	**420**	**54,43**
	movements	

Figure 8 Scope incl. TBA label

INBOUND DESTINATIONS					
Zone	UM's	%	Cum%	ABC	lanes
BEL-1	40	19%	19%	A	3
BEL-8	38	18%	38%	A	3
BEL-2	34	16%	54%	A	3
BEL-9	30	14%	69%	A	3
BEL-7	25	12%	81%	B	2
BEL-6	14	7%	87%	B	1
BEL-4	10	5%	92%	B	1
BEL-3	5	2%	95%	C	1
BEL-5	4	2%	97%	C	1
DEU-5	1	0%	97%	C	1
DEU-8	1	0%	98%	C	1
DNK-8	1	0%	98%	C	1
FRA-0	1	0%	99%	C	1
FRA-5	1	0%	99%	C	1
FRA-9	1	0%	100%	C	1
PRT-4	1	0%	100%	C	1
total	*207*				
+TBA	213				

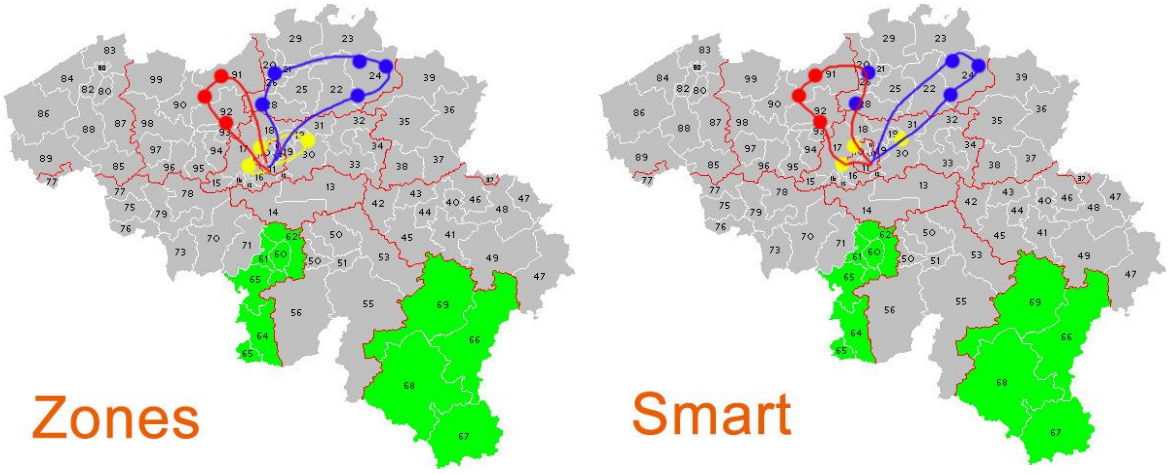
Figure 7 Scope excl. TBA label

File: Crossdocking 5 scope.xlsx

3.3.2.3 Smart routes

The stops around **Brussels** should be incorporated into other routes. Specific routes for Brussels can cause a lot of unpredictabilities and delays. Spreading these out to other routes creates a more certainty on the delivery times.

A second adaptation happens by looking at the distance between **destinations without zone borders** as displayed in the following illustration:



3.3.2.3.1 Why do we want Smart routes?

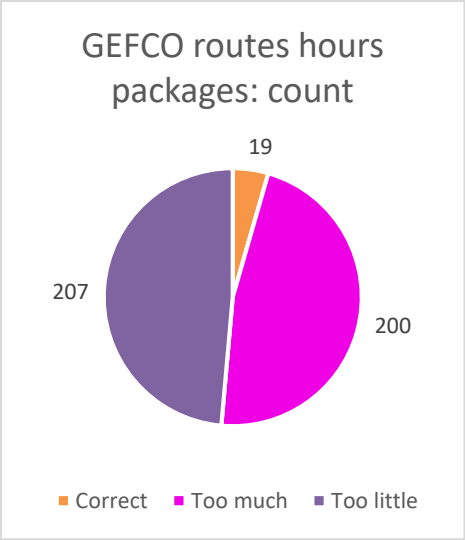
These were the findings after the data analysis from the **GEFCO routes**.

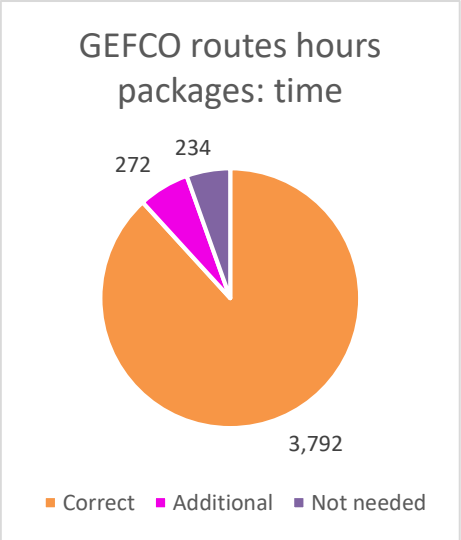
File: excel3.xlsx

	Sum (hr)	%	Count	%	Average (hr)
Delivery time (HOURS)	4.298		426		
Hours package	4.260		426		
Additional hours	272	6%	200	47%	1,36
Hours not needed	234	5%	207	49%	1,13
Wrong	506	12%	407	96%	1,24
Correct	3.792	88%	19		
	Sum (km)	%	Count	%	Average (km)
Actual KM's	121.147		426		
KM package	134.950		426		
Additional kilometers	7.697	6%	150	35%	51,31
KM's not needed	21.500	18%	263	62%	81,75
Wrong	29.197	24%	413	97%	70,69
Correct	91.950	76%	13		
Total data lines	426				

Figure 9 GEFCO routes data

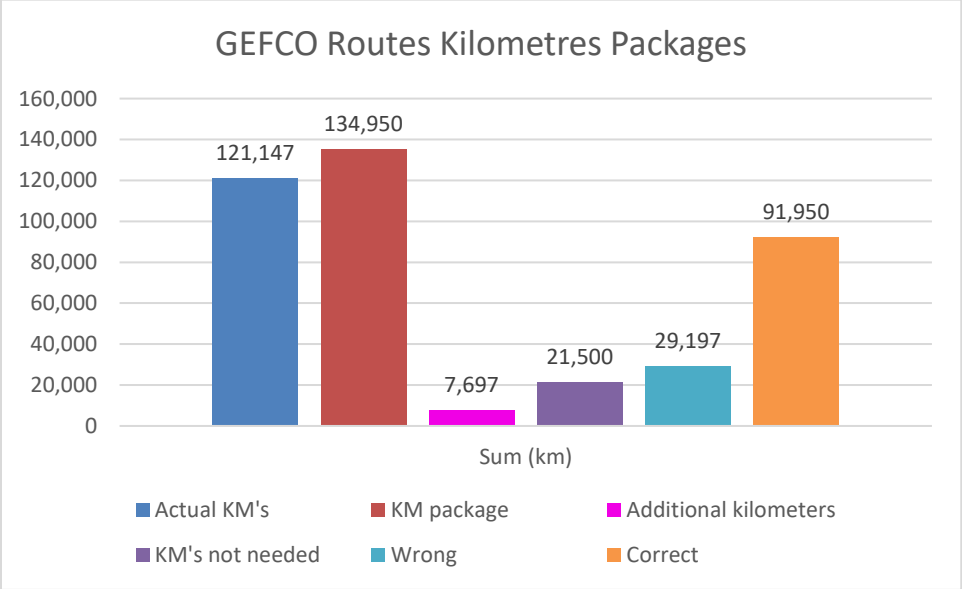
We are **not** using the simulation scope here!





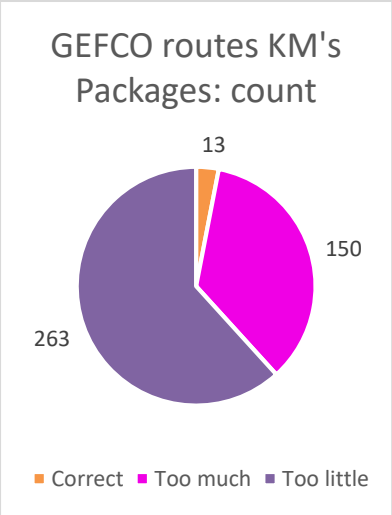
Hours packages

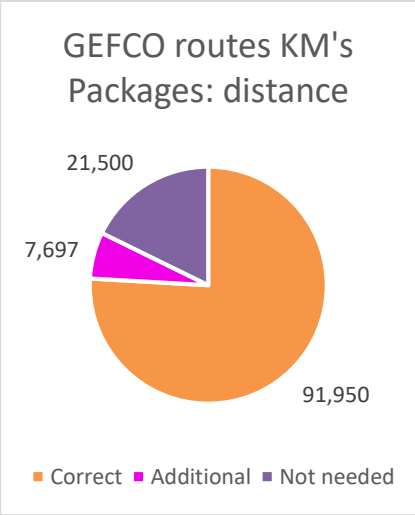
Out of the 426 routes, 200 routes have too much hours and 207 routes too little.
Out of the 4298 hours (delivery time), 272 hours are additional (on top of package) and 234 hours are not needed.



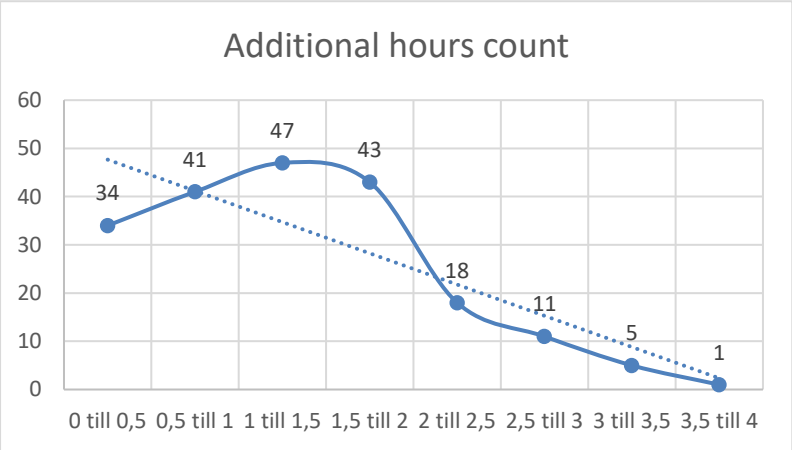
Kilometres packages

Out of all the route data GEFCO has a total of 134.950 km with the KM packages. The Actual KM's is 10% lower with 121.147 km. 7.697 km is additional, 21.500 km is unnecessary. This adds up to total wrong amount of KM's of 29.197 km. Next to this 91.950 km was correct.





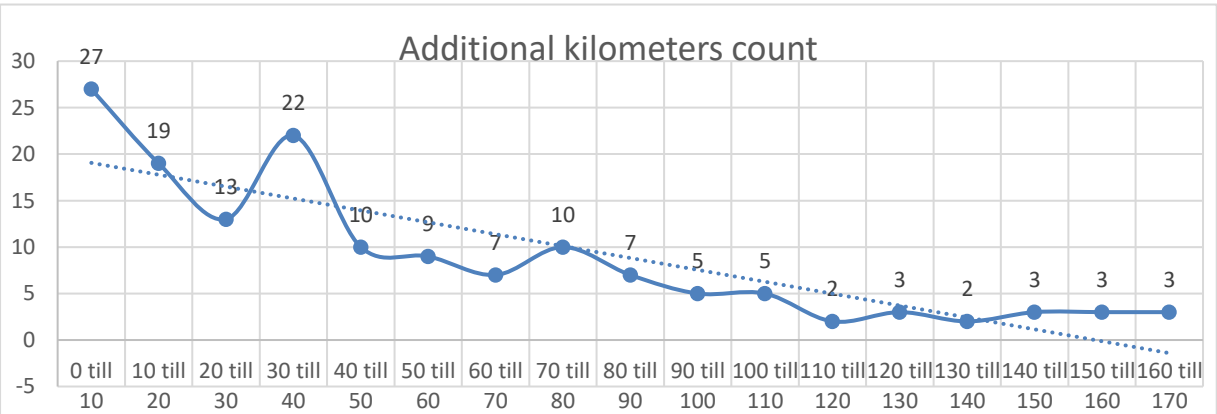
Out of the 426 routes, 150 routes have too much kilometres and 263 routes have too little kilometres. Out of the 121.147 kilometres (Actual KM's, correct + wrong), 7.697 km is additional (on top of package) and 21.500 km is not needed. **97% Of the routes has the wrong KM Package with a total of 29.197 km wrong**.



Delivery time (HOURS) Decimal	
13,52	1,41% above 13hrs
13,50	
13,42	
13,25	
13,25	
13,08	

47 Routes have 1 to 1,5 hours on top of the Hours Package.

6 Routes have a delivery time of 13 hours or more (1,41%).



- 27 routes have an additional 0 to 10 km.
- 19 routes have an additional 10 to 20km.
- 13 routes have an additional 30 to 40 km.
- 22 routes have an additional 40 to 50km.

All these results are **not attractive for new drivers**, this is why we need to implement smart routes.

3.4 Simulation of AS-IS and TO-BE VDS

Figure 10 TO-BE VDS: Simulation

3.4.1 Pareto analysis

Basically, the simulation makes a **Pareto analysis** of the UM's per destination from the incoming merchandise (our **scope**). The software will then allocate the merchandise efficiently throughout the warehouse to minimise driving distance.

It is important to know that the merchandise from inbound zone to dock-lanes is grouped per postal code ("BEL-2200" becomes "BEL-2"). These are hardly the best routes possible. We would opt for smart routes that are more efficient, generated by software or a staff member. See above, part 3.3.3 Smart Routes.

This **automation algorithm** can be applied to the **high-tech solution** as well.

3.4.2 Simulation parameters

To measure the occupancy rate, we assume to be working only with Pallets (PT) as handling units (UM's). Assuming we cross-dock within 24 hours, goods should never stay longer than a day, items staying longer than 2 days will be moved to the storage area, to avoid obstructing the variable flow.

- 1 UM = 1 movement
- Dock-lane length: 9 m
- Dock-lane width: 120 m / 37 = 3,24 m
- 1 PT: 1,20 m x 0,80 m
- PT Capacity 1 lane: (9 m / 1,20 m) x 2 = 14 pallets
- Free dock-lane space with full capacity = 3,24 m – (2 x 0,8 m) = ± 1,60 m

3.4.3 Warehouse measures

Figure 11 GEFCO Braine Satellite picture

	scale	reality
	cm	m
	2,00	20,00
width	3,00	30,00
length	12,00	120,00
²		3600,00

We are dealing with 3600 m² at GEFCO Braine. 120 m long and 30 m wide. We used these measures to discover the dock-lane length calculated above.

3.4.4 AS-IS simulator

Time calculations in seconds	
Constants	**Forklift**
Arriving inbound and grabbing pallet on forklift	10
Acceleration	5
Turn	3
Turn	3
Put pallet down and turn around	15
Turn	3
Turn	3
	42

Variable	Forklift
Speed in m/s	2,2
Average operator waste	1,1

Rest Surcharge in %

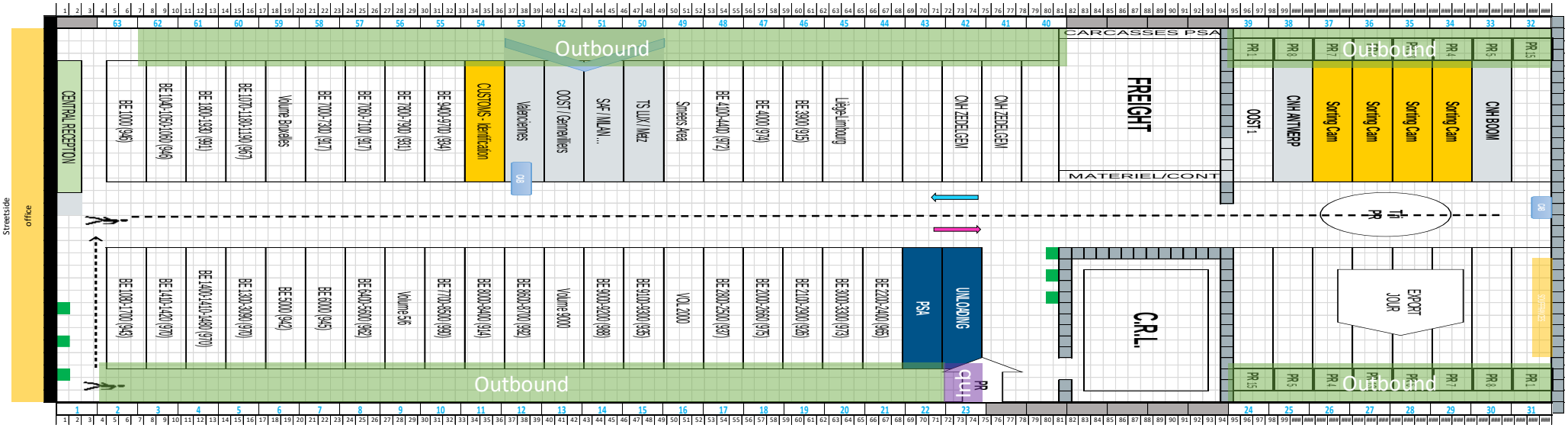
ting in kg	ca. 90° gebukt	ca. 45° gebukt	achterover, handen bo-ven hoofd	45°- 90° draaiend	
					
0 - 1	23	16	20	8	6
1 – 3	24	17	21	9	7
3 – 6	26	19	23	10	9
6- 10	28	21	25	12	10
10 - 15	30	23	27	14	12

File: Crossdocking 5 sim.xlsx

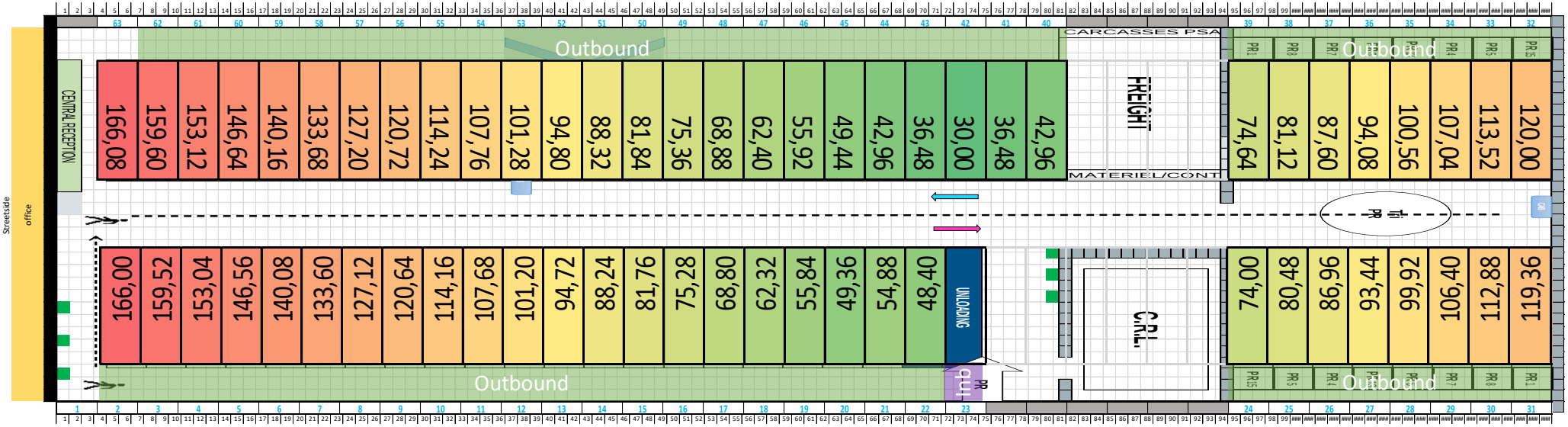
This page shows the **simulator** of the AS-IS that runs in the background of the warehouse map. It allocates the UM's to the fixed dock-lanes for the total amount of UM's.

AS-IS		2.912,72	2.858,72	5.771,44	5.657,72			207,00	20.929,92	20.028,36
dock-lane nr.	Kind	inb-dock (meter)	dock-inb (meter)	full cycle (meter)	full cycle time (seco	fixed zone	destination zone	UM's	travelled (meters)	travelled time (seco
1	Entrance									
2	Outbound	86,00	80,00	166,00	129,20	1			-	-
3	Outbound	82,76	76,76	159,52	125,96	1			-	-
4	Outbound	79,52	73,52	153,04	122,72	1			-	-
5	Outbound	76,28	70,28	146,56	119,48	1	BEL-1	14	2.051,84	1.672,72
6	Outbound	73,04	67,04	140,08	116,24	5	BEL-5	4	560,32	464,96
7	Outbound	69,80	63,80	133,60	113,00	6			-	-
8	Outbound	66,56	60,56	127,12	109,76	6			-	-
9	Outbound	63,32	57,32	120,64	106,52	6	BEL-6	14	1.688,96	1.491,28
10	Outbound	60,08	54,08	114,16	103,28	7	BEL-7	14	1.598,24	1.445,92
11	Outbound	56,84	50,84	107,68	100,04	8	BEL-8	14	1.507,52	1.400,56
12	Outbound	53,60	47,60	101,20	96,80	8	BEL-8	14	1.416,80	1.355,20
13	Outbound	50,36	44,36	94,72	93,56	9	BEL-9	14	1.326,08	1.309,84
14	Outbound	47,12	41,12	88,24	90,32	9	BEL-9	14	1.235,36	1.264,48
15	Outbound	43,88	37,88	81,76	87,08	9	BEL-8	10	817,60	870,80
16	Outbound	40,64	34,64	75,28	83,84	2			-	-
17	Outbound	37,40	31,40	68,80	80,60	2			-	-
18	Outbound	34,16	28,16	62,32	77,36	2	BEL-2	6	373,92	464,16
19	Outbound	30,92	24,92	55,84	74,12	2	BEL-2	14	781,76	1.037,68
20	Outbound	27,68	21,68	49,36	70,88	3	BEL-3	5	246,80	354,40
21	Outbound	24,44	30,44	54,88	73,64	2	BEL-2	14	768,32	1.030,96
22	PSA	21,20	27,20	48,40	70,40	PSA			-	-
23	Unloading								-	-
23,1	C.R.L								-	-
23,2	C.R.L								-	-
23,3	C.R.L								-	-
23,4	C.R.L								-	-
23,5	C.R.L								-	-
23,6	C.R.L								-	-
24	Export	34,00	40,00	74,00	83,20		DEU-5	1	74,00	83,20
25	Export	37,24	43,24	80,48	86,44		DEU-8	1	80,48	86,44
26	Export	40,48	46,48	86,96	89,68		DNK-8	1	86,96	89,68
27	Export	43,72	49,72	93,44	92,92		FRA-0	1	93,44	92,92
28	Export	46,96	52,96	99,92	96,16		FRA-5	1	99,92	96,16
29	Export	50,20	56,20	106,40	99,40		FRA-9	1	106,40	99,40
30	Export	53,44	59,44	112,88	102,64		PRT-4	1	112,88	102,64
31	Storrage	56,68	62,68	119,36	105,88				-	-
32	Storrage	60,00	60,00	120,00	106,20				-	-
33	Outbound	56,76	56,76	113,52	102,96				-	-
34	Outbound	53,52	53,52	107,04	99,72				-	-
35	Outbound	50,28	50,28	100,56	96,48				-	-
36	Outbound	47,04	47,04	94,08	93,24				-	-
37	Outbound	43,80	43,80	87,60	90,00				-	-
38	Outbound	40,56	40,56	81,12	86,76				-	-
39	Outbound	37,32	37,32	74,64	83,52				-	-
39,1	Freight								-	-
39,2	Freight								-	-
39,3	Freight								-	-
39,4	Freight								-	-
40	Outbound	21,48	21,48	42,96	67,68				-	-
41	Outbound	18,24	18,24	36,48	64,44				-	-
42	Outbound	15,00	15,00	30,00	61,20				-	-
43	Outbound	18,24	18,24	36,48	64,44				-	-
44	Outbound	21,48	21,48	42,96	67,68				-	-
45	Outbound	24,72	24,72	49,44	70,92				-	-
46	Outbound	27,96	27,96	55,92	74,16	3			-	-
47	Outbound	31,20	31,20	62,40	77,40	4	BEL-4	10	624,00	774,00
48	Outbound	34,44	34,44	68,88	80,64	4			-	-
49	Outbound	37,68	37,68	75,36	83,88				-	-
50	Outbound	40,92	40,92	81,84	87,12				-	-
51	Outbound	44,16	44,16	88,32	90,36				-	-
52	Outbound	47,40	47,40	94,80	93,60				-	-
53	Outbound	50,64	50,64	101,28	96,84				-	-
54	Outbound	53,88	53,88	107,76	100,08				-	-
55	Outbound	57,12	57,12	114,24	103,32	9	BEL-9	2	228,48	206,64
56	Outbound	60,36	60,36	120,72	106,56	7	BEL-7	11	1.327,92	1.172,16
57	Outbound	63,60	63,60	127,20	109,80	7			-	-
58	Outbound	66,84	66,84	133,68	113,04	7			-	-
59	Outbound	70,08	70,08	140,16	116,28	1	BEL-1	14	1.962,24	1.627,92
60	Outbound	73,32	73,32	146,64	119,52	1	BEL-1	12	1.759,68	1.434,24
61	Outbound	76,56	76,56	153,12	122,76	1			-	-
62	Outbound	79,80	79,80	159,60	126,00	1			-	-
63	Outbound	83,04	83,04	166,08	129,24	1			-	-

3.4.5 AS-IS warehouse map

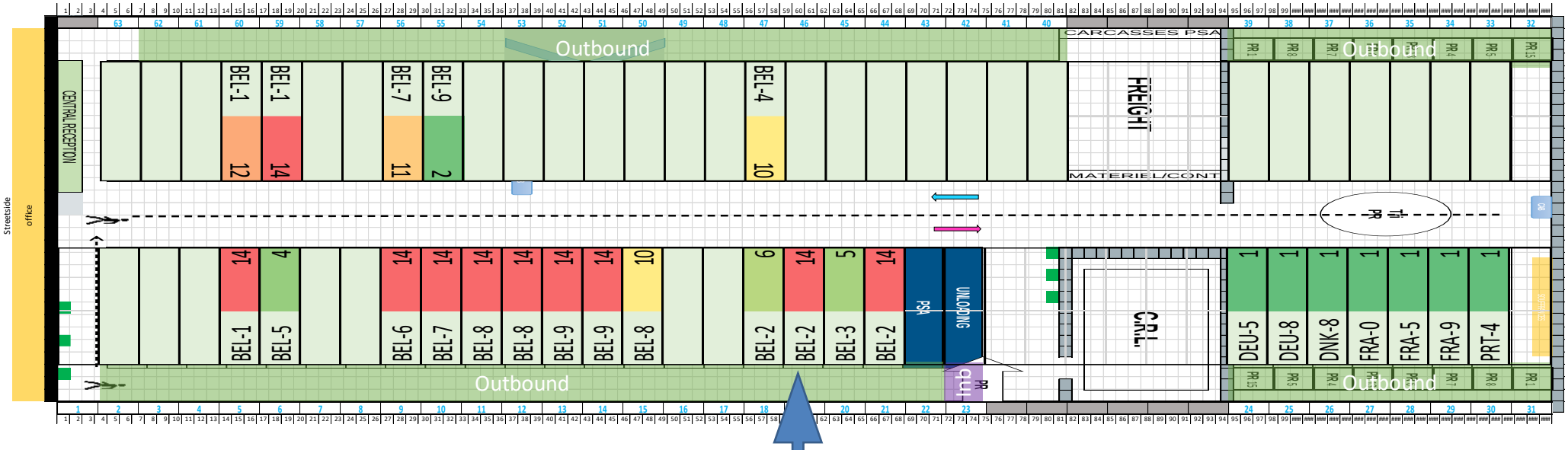


Scale: 1 cube = 1 meter by 1 meter. All drawn in scale.



AS-IS driving distance heatmap: full cycle (leaving and returning) in meters from centre of unloading to centre of dock-lane.

3.4.6 AS-IS simulation warehouse map



AS-IS on 7/08/2018 of 207 UM's (scope)

This AS-IS simulation shows that UM's are being put in their **fixed position**. This is an inefficient workflow because it does not take the distance of all the movements into account.

The colour indicates when a dock-lane is nearly full or not. The max capacity is indicated with a red 14. Example: dock-lane 18 has 6 UM's going to BEL-2.

Imagine a day where we would only need to move 28 UM's that have to go to Brussels. You would need to move them 1 by 1 to dock-lane 60 and dock-lane 5. Creating a lot of work. While you could easily put them all at the closest location of the inbound on dock-lane 20 and 21. Those movements would be done a lot faster.

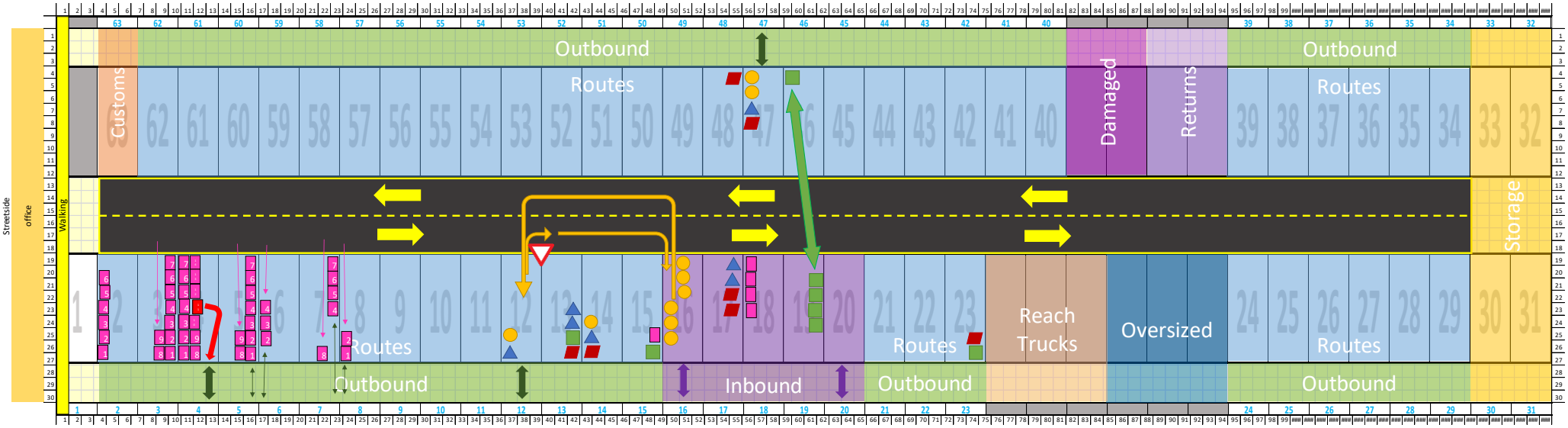
The **TO-BE VDS** simulation will show you the solution.

3.4.7 TO-BE VDS simulator

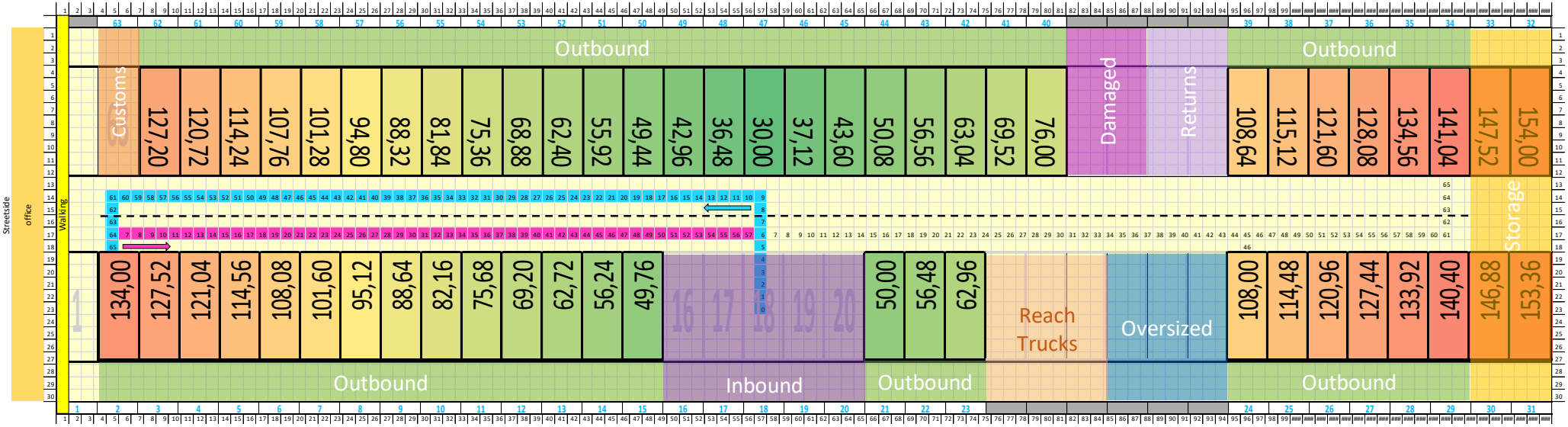
TO-BE		2.611,64	2.593,64	5.205,28	5.189,84		-	207,00	10.569,12	14.847,96
dock-lane nr.	Kind	inb-dock (meter)	dock-inb (meter)	full cycle (meter)	full cycle time (seconds)	allocation order	Allocation	UM's	travelled (meters)	travelled time (seconds)
1	Entrance									
2	Outbound	70,00	64,00	134,00	113,20	49			-	-
3	Outbound	66,76	60,76	127,52	109,96	46			-	-
4	Outbound	63,52	57,52	121,04	106,72	42			-	-
5	Outbound	60,28	54,28	114,56	103,48	38			-	-
6	Outbound	57,04	51,04	108,08	100,24	34			-	-
7	Outbound	53,80	47,80	101,60	97,00	31			-	-
8	Outbound	50,56	44,56	95,12	93,76	29			-	-
9	Outbound	47,32	41,32	88,64	90,52	27			-	-
10	Outbound	44,08	38,08	82,16	87,28	25	PRT-4	1	82,16	87,28
11	Outbound	40,84	34,84	75,68	84,04	22	FRA-0	1	75,68	84,04
12	Outbound	37,60	31,60	69,20	80,80	19	DEU-5	1	69,20	80,80
13	Outbound	34,36	28,36	62,72	77,56	15	BEL-6	14	878,08	1.085,84
14	Outbound	31,12	25,12	56,24	74,32	11	BEL-9	14	787,36	1.040,48
15	Outbound	27,88	21,88	49,76	71,08	7	BEL-2	14	696,64	995,12
16	Inbound								-	-
17	Inbound								-	-
18	Inbound								-	-
19	Inbound								-	-
20	Inbound								-	-
21	Outbound	22,00	28,00	50,00	71,20	8	BEL-2	14	700,00	996,80
22	Outbound	25,24	31,24	56,48	74,44	12	BEL-9	2	112,96	148,88
23	Outbound	28,48	34,48	62,96	77,68	16	BEL-4	10	629,60	776,80
23,1	Reachtrucks								-	-
23,2	Reachtrucks								-	-
23,3	Reachtrucks								-	-
23,4	Oversized								-	-
23,5	Oversized								-	-
23,6	Oversized								-	-
24	Outbound	51,00	57,00	108,00	100,20	33			-	-
25	Outbound	54,24	60,24	114,48	103,44	37			-	-
26	Outbound	57,48	63,48	120,96	106,68	41			-	-
27	Outbound	60,72	66,72	127,44	109,92	45			-	-
28	Outbound	63,96	69,96	133,92	113,16	48			-	-
29	Outbound	67,20	73,20	140,40	116,40	51			-	-
30	Storrage	70,44	76,44	146,88	119,64	53			-	-
31	Storrage	73,68	79,68	153,36	122,88	55			-	-
32	Storrage	77,00	77,00	154,00	123,20	56			-	-
33	Storrage	73,76	73,76	147,52	119,96	54			-	-
34	Outbound	70,52	70,52	141,04	116,72	52			-	-
35	Outbound	67,28	67,28	134,56	113,48	50			-	-
36	Outbound	64,04	64,04	128,08	110,24	47			-	-
37	Outbound	60,80	60,80	121,60	107,00	43			-	-
38	Outbound	57,56	57,56	115,12	103,76	39			-	-
39	Outbound	54,32	54,32	108,64	100,52	35			-	-
39,1	Returns								-	-
39,2	Returns								-	-
39,3	Damaged								-	-
39,4	Damaged								-	-
40	Outbound	38,00	38,00	76,00	84,20	23	FRA-5	1	76,00	84,20
41	Outbound	34,76	34,76	69,52	80,96	20	DEU-8	1	69,52	80,96
42	Outbound	31,52	31,52	63,04	77,72	17	BEL-3	5	315,20	388,60
43	Outbound	28,28	28,28	56,56	74,48	13	BEL-7	14	791,84	1.042,72
44	Outbound	25,04	25,04	50,08	71,24	9	BEL-2	6	300,48	427,44
45	Outbound	21,80	21,80	43,60	68,00	5	BEL-8	14	610,40	952,00
46	Outbound	18,56	18,56	37,12	64,76	3	BEL-1	12	445,44	777,12
47	Outbound	15,00	15,00	30,00	61,20	1	BEL-1	14	420,00	856,80
48	Outbound	18,24	18,24	36,48	64,44	2	BEL-1	14	510,72	902,16
49	Outbound	21,48	21,48	42,96	67,68	4	BEL-8	14	601,44	947,52
50	Outbound	24,72	24,72	49,44	70,92	6	BEL-8	10	494,40	709,20
51	Outbound	27,96	27,96	55,92	74,16	10	BEL-9	14	782,88	1.038,24
52	Outbound	31,20	31,20	62,40	77,40	14	BEL-7	11	686,40	851,40
53	Outbound	34,44	34,44	68,88	80,64	18	BEL-5	4	275,52	322,56
54	Outbound	37,68	37,68	75,36	83,88	21	DNK-8	1	75,36	83,88
55	Outbound	40,92	40,92	81,84	87,12	24	FRA-9	1	81,84	87,12
56	Outbound	44,16	44,16	88,32	90,36	26			-	-
57	Outbound	47,40	47,40	94,80	93,60	28			-	-
58	Outbound	50,64	50,64	101,28	96,84	30			-	-
59	Outbound	53,88	53,88	107,76	100,08	32			-	-
60	Outbound	57,12	57,12	114,24	103,32	36			-	-
61	Outbound	60,36	60,36	120,72	106,56	40			-	-
62	Outbound	63,60	63,60	127,20	109,80	44			-	-
63	Customs									-

This page shows the **simulator** of the TO-BE VDS that runs in the background of the warehouse map. It allocates the UM's to the closest dock-lane to have a **minimum of travel time and distance** for the total amount of UM's.

3.4.8 TO-BE VDS warehouse map

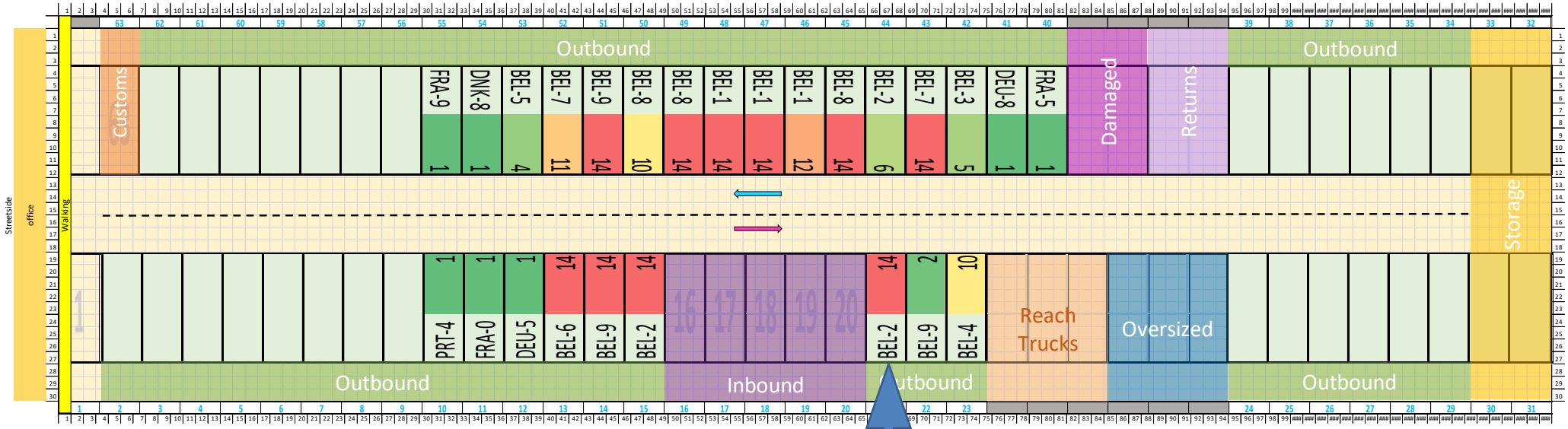


Scale: 1 cube = 1 meter by 1 meter. All drawn in scale.



TO-BE VDS driving distance heatmap: full cycle (leaving and returning) in meters from centre of unloading to centre of dock-lane.

3.4.9 TO-BE VDS simulation warehouse map



TO-BE VDS on 7/08/2018 of 207 UM's

After running the simulator with the **Variable Dock-lane System** you see a huge difference. The same UM's are being put as close as possible to the inbound zone to minimise the distance.

As before, the colour indicates when a dock-lane is nearly full or not. The max capacity is indicated with a red 14. Example: dock-lane 21 has 14 UM's going to BEL-2.

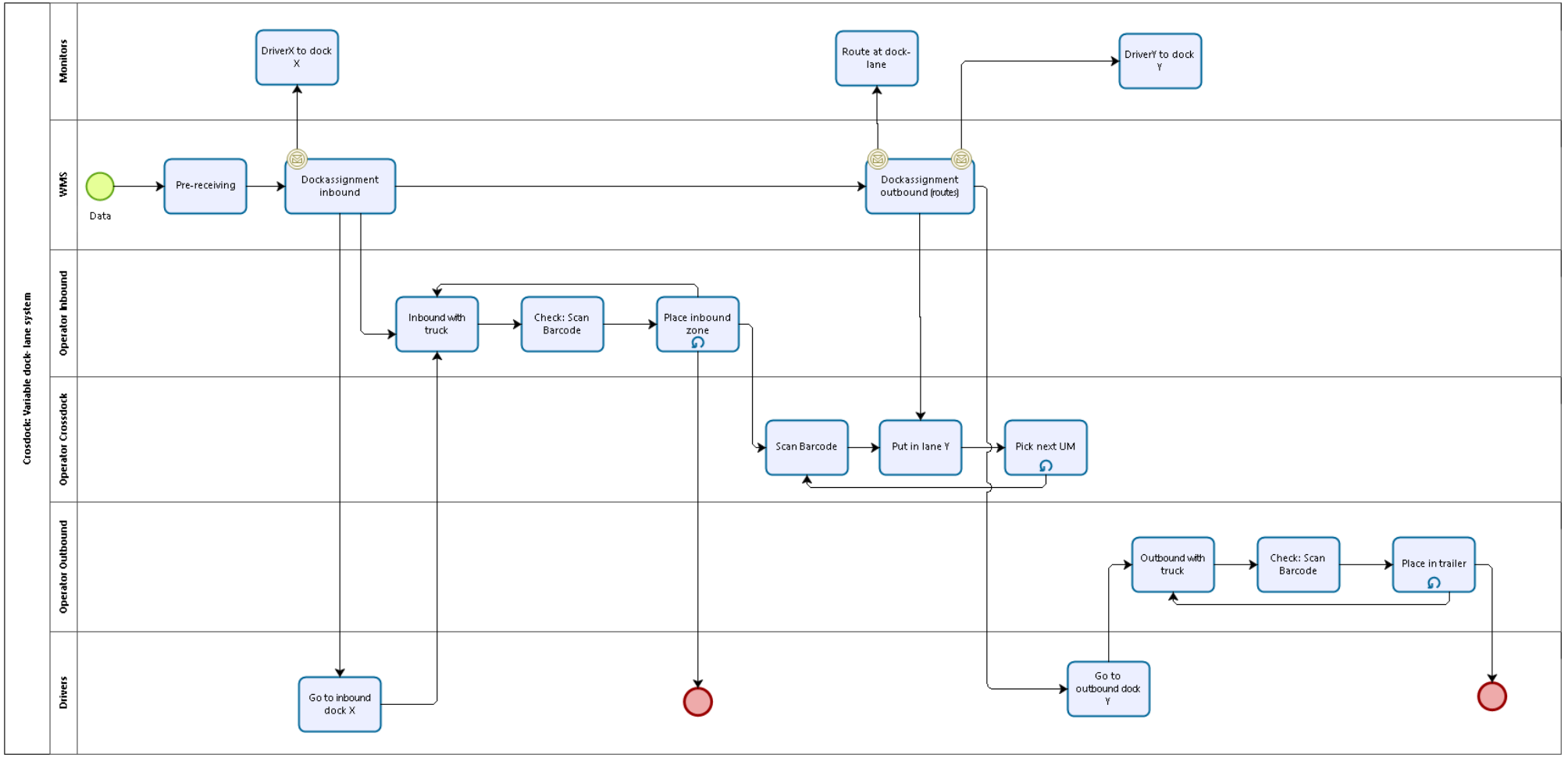
Doing the same job with substantial less distance and in much less time will result in a higher productivity.

To further increase productivity we will show a high-tech solution in the next chapter.

INBOUND DESTINATIONS					
Zone	UM's	%	Cum%	ABC	lanes
BEL-1	40	19%	19%	A	3
BEL-8	38	18%	38%	A	3
BEL-2	34	16%	54%	A	3
BEL-9	30	14%	69%	A	3
BEL-7	25	12%	81%	B	2
BEL-6	14	7%	87%	B	1
BEL-4	10	5%	92%	B	1
BEL-3	5	2%	95%	C	1
BEL-5	4	2%	97%	C	1
DEU-5	1	0%	97%	C	1
DEU-8	1	0%	98%	C	1
DNK-8	1	0%	98%	C	1
FRA-0	1	0%	99%	C	1
FRA-5	1	0%	99%	C	1
FRA-9	1	0%	100%	C	1
PRT-4	1	0%	100%	C	1
total	*207*				
+TBA	213				

Figure 12 Scope: inbound destinations

3.4.10TO BE VDS workflow map



3.4.11TO-BE VDS workflow process

The entire workflow is explained in detail in the next chapter of our high-tech TO-BE AGV.

- ➔ Pre-receiving (date, time, place of delivery, UM, dimensions, weight, barcode)
- ➔ Dock assignment inbound (real-time communication: monitor, operator, driver)
- ➔ Inbound (barcode, RFID)
- ➔ Automated data-driven dock-lane allocation (real-time communication: monitor, operator, driver)
- ➔ Outbound (RFID, barcode)

3.4.12Traffic rules and safety

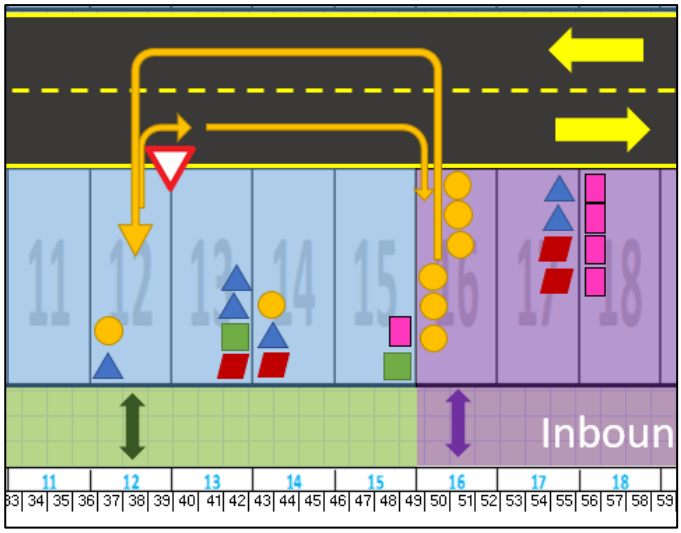


Figure 13 TO-BE VDS Traffic rules and safety

Figure 14 Safety mirror

We created a **one-way system** in the central lane. Operators can always cross safely to the other side. Operators should always give way to other operators on the central lane when coming from a dock-lane, indicated here at dock-lane 12 with ▽

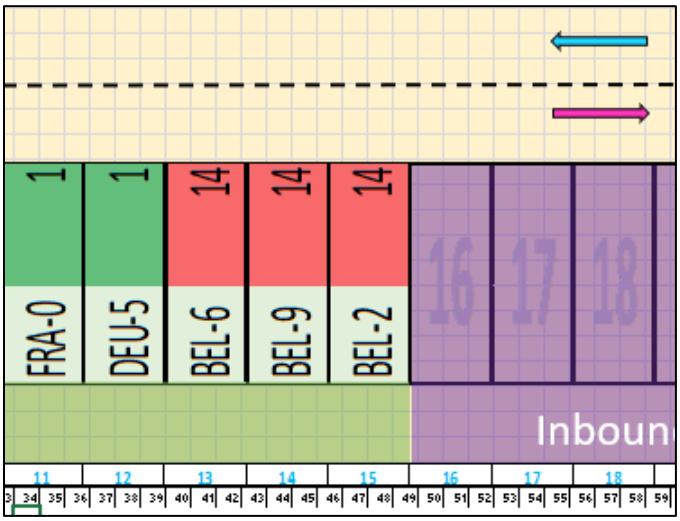


Figure 15 TO-BE VDS Dock-lane allocation

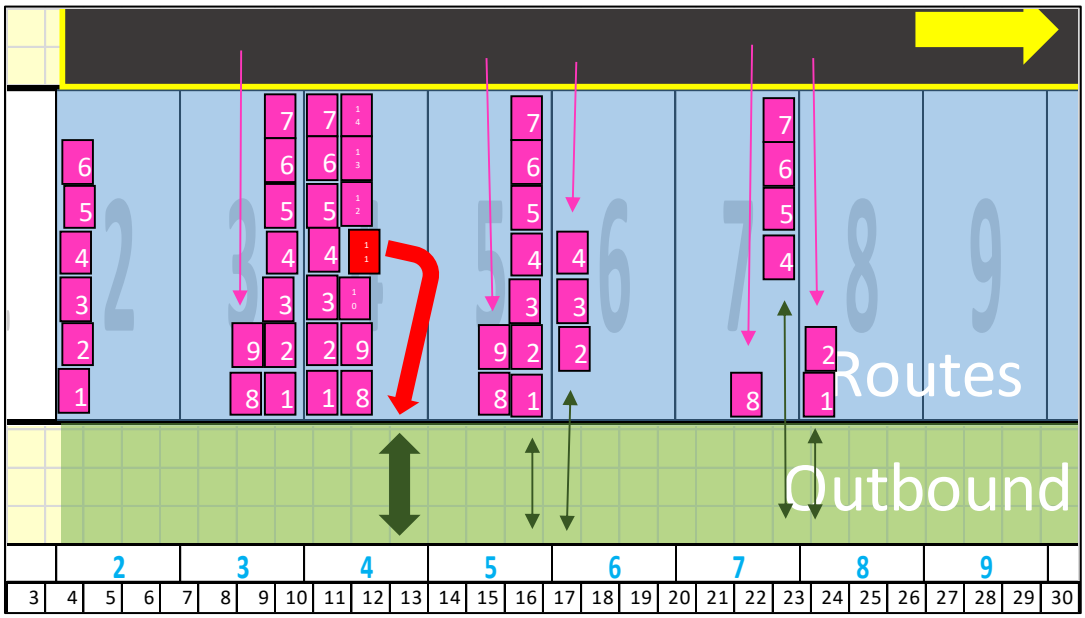
Above the centre lane, **safety mirrors** will provide extra visuals for the drivers. Drivers should always make **eye contact** before making any manoeuvre in the proximity of another driver.

To help clarify which dock-lane contains which zone (or route), **monitors** can be placed above the lanes. In this simulation dock-lane 17 monitor will display “DEU-5”.

However, the operator does not need to know what route he needs to go to. All he or she needs to know is the lane number, which is always the same as the dock number.

File: Crossdocking 5 sim.xlsx

3.4.13 Dock-lane operations



File: Crossdocking 5 sim.xlsx

3.4.13.1 Reminder: parameters

- ✓ 1 UM = 1 movement
- ✓ Dock-lane length: 9 m
- ✓ Dock-lane width: 120 m / 37 = 3,24 m
- ✓ 1 PT: 1,20 m x 0,80 m
- ✓ PT Capacity 1 lane: (9 m / 1,20 m) x 2 = 14 pallets
- ✓ Free dock-lane space with full capacity = 3,24 m – (2 x 0,8 m) = ± 1,60 m

3.4.13.2 Dock-lane filling and emptying

Placing a maximum of 14 pallets side by side per dock-lane gives us a jointed free space with the neighbouring dock-lane of 2 x ± 1,60 m = ± 3,20 m. Enough space for the **forklift and its turning circle** to place or remove pallets from the side if necessary.

In a perfect situation (when the sequence to load the truck is known) the WMS will tell the operator in which exact location a pallet should be placed.

In case of unknown sequence, the operator starts filling the dock-lane in the corner as shown here (1) until you reach the maximum capacity of 1 row, followed by the next row (8). Please note that some PT's might be **stackable**.

Rule: Always place UM's at the side of the odd number lower than the next even number: [2], [3,4], [5,6], [7,8] …

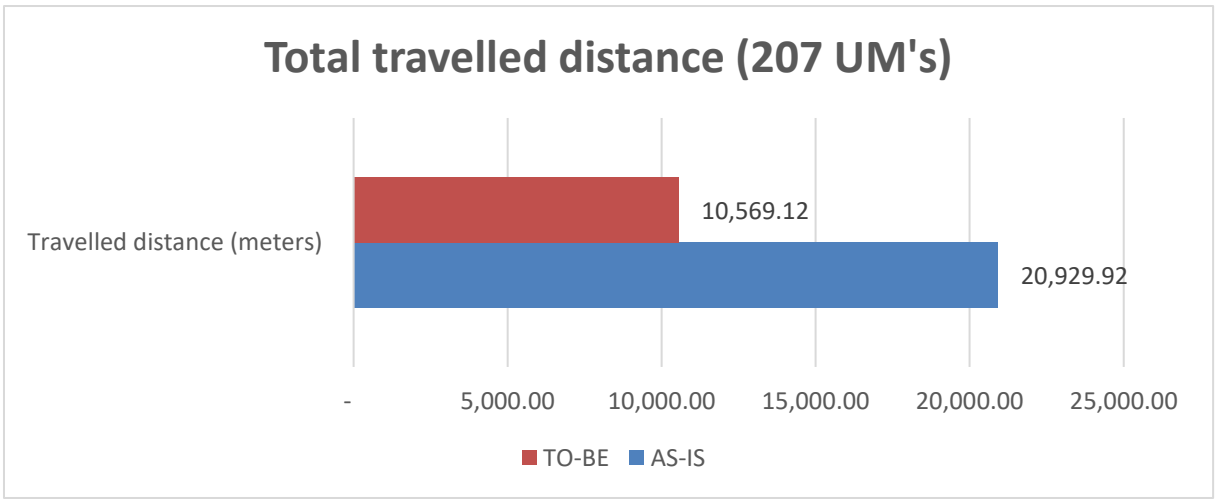
The same rules apply for the inbound operations in the other direction.

3.4.13.3 A new problem with a new solution

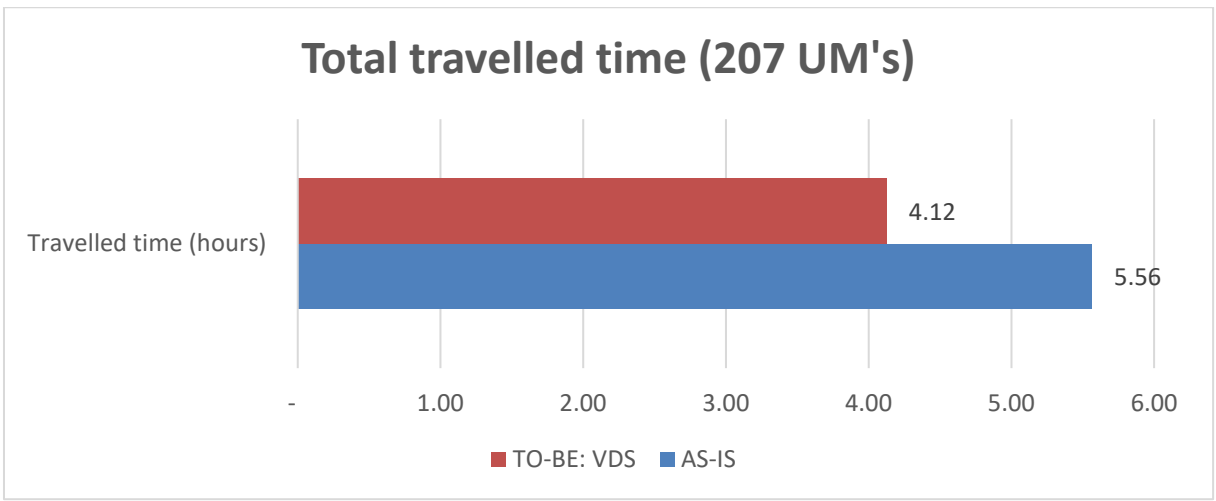
These specific dock-lane operations might create a **bottleneck** at full capacity. Especially when we don't know the sequence beforehand. Our **high-tech solution** will provide a perfect solution to this issue.

3.5 VDS results

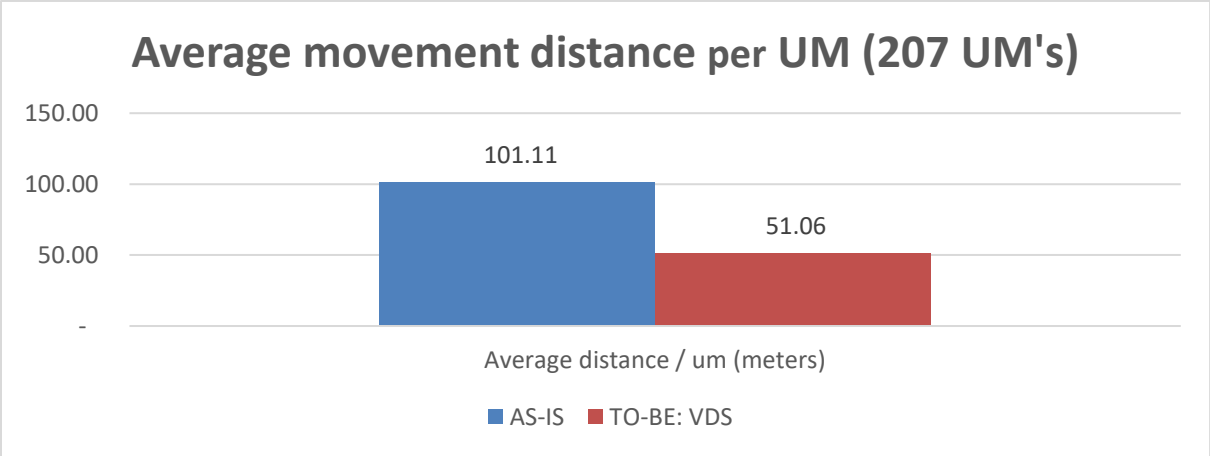
Figure 16 TO-BE VDS Result



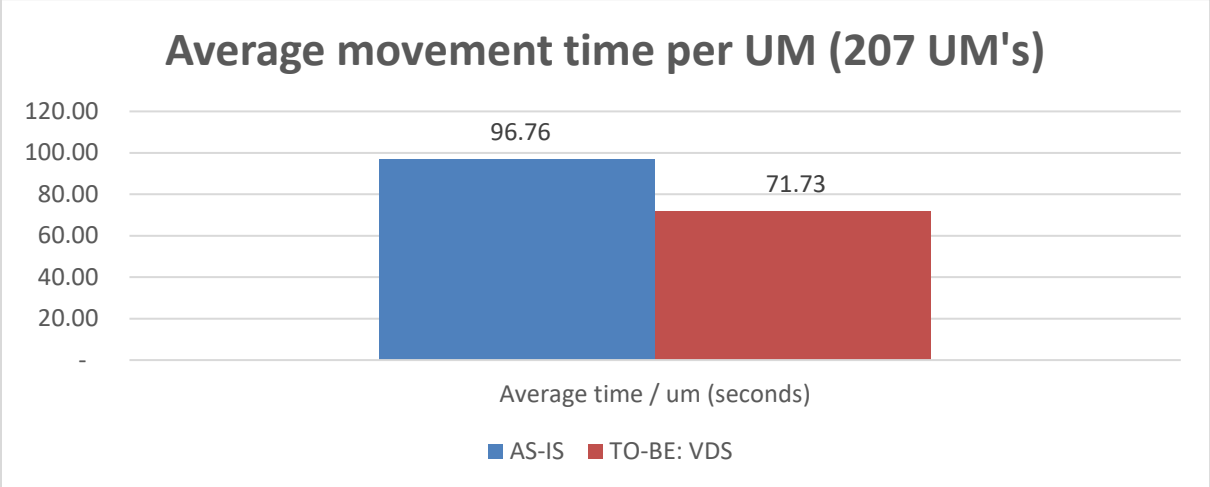
The **travelled distance is 50% lower** in the TO-BE VDS. From 20,9 km to 10,6 km.



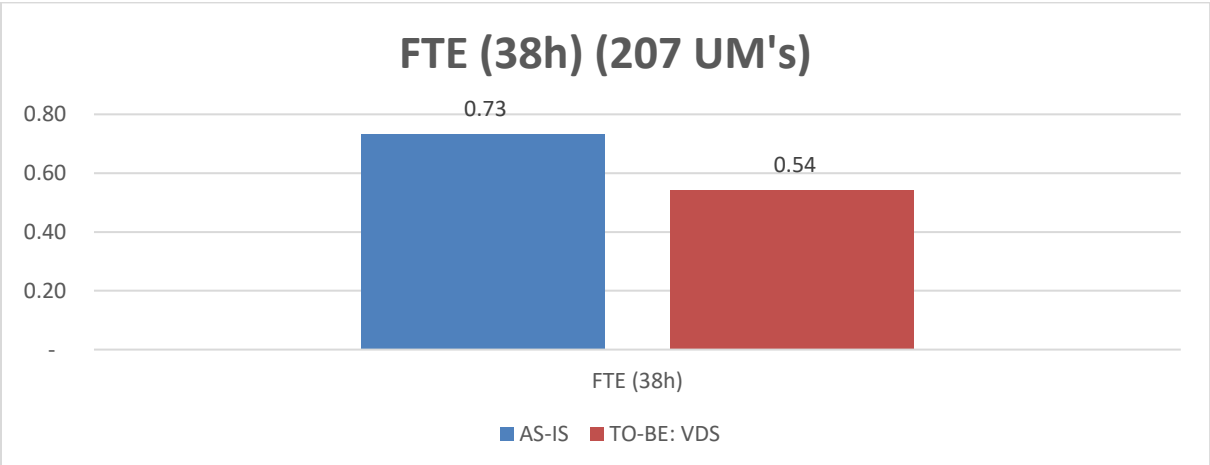
The **travelled time is decreased with 26%** in the TO-BE VDS. From 5,56 hours to 4,12 hours.



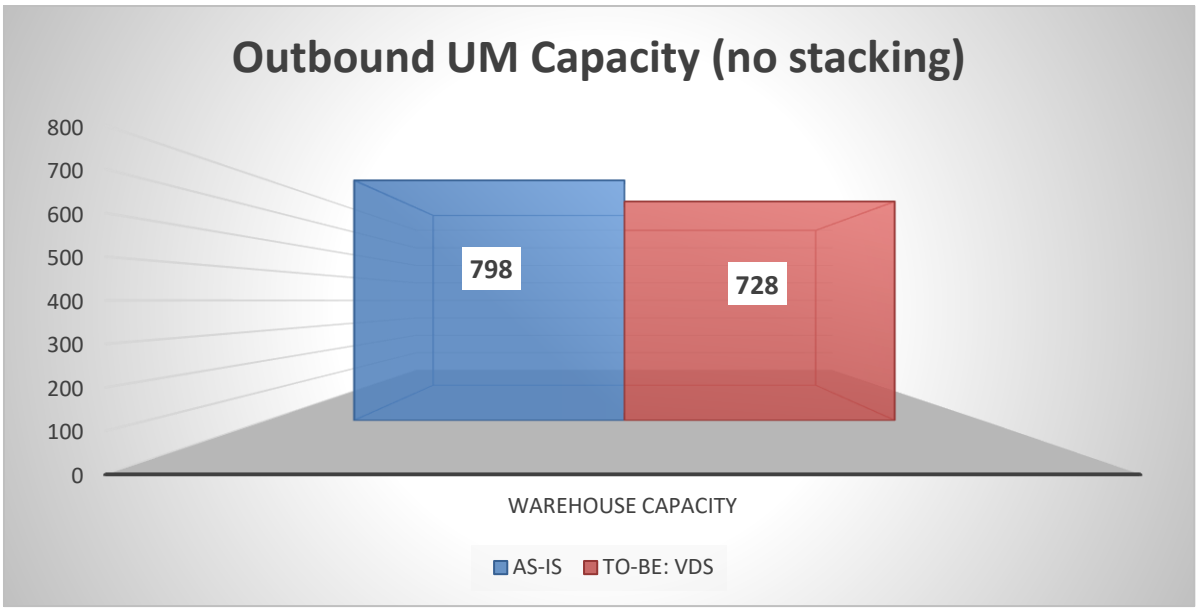
The **average movement distance per UM** of the TO-BE VDS is **50% shorter** than the AS-IS



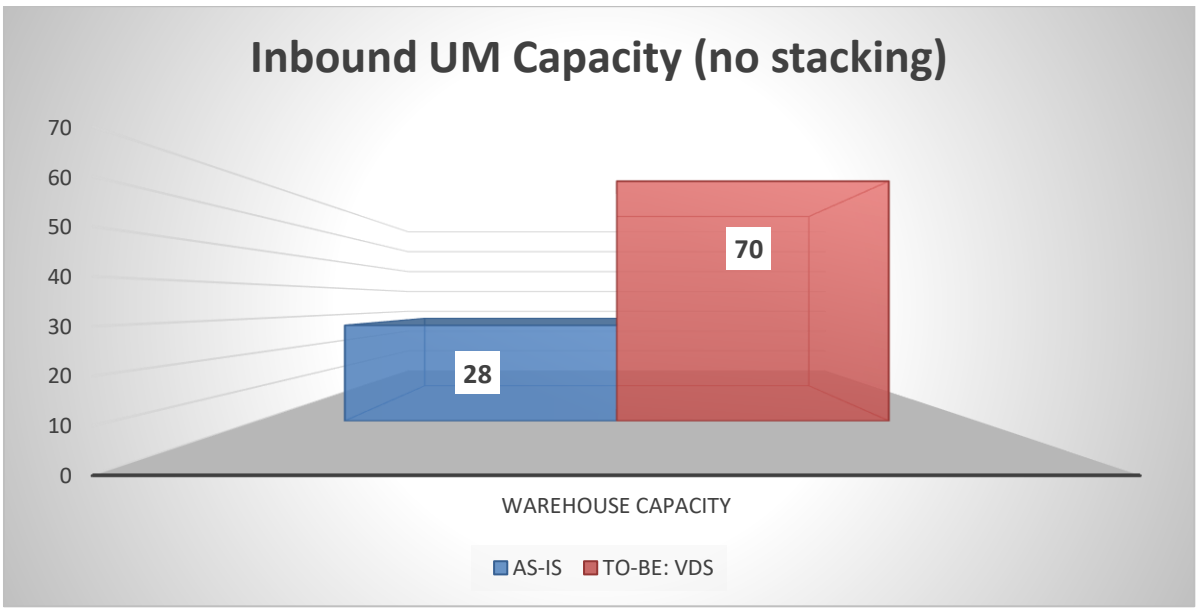
The **average movement time per UM** is **26% lower** than the AS-IS, 72 seconds instead of 97 seconds.



When we change the worked time to full time equivalent operators with a 38 hours a week contract, we only need 0,54 FTE instead of 0,73 FTE for this simulation of 200 UM's. That's **26% less FTE**.



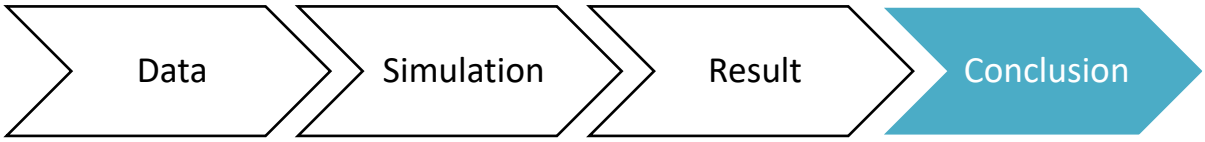
For the outbound operations we have a total capacity of 728 UM's in the TO-BE VDS.



For the inbound operations we have a total capacity of 70 UM's. **150% more UM capacity** for the inbound allows for a better management of peak hours.

File: Crossdocking 5 result.xlsx

3.6 VDS conclusion



It was the intention to **optimise the cross-dock operations** with a Variable Dock-lane System allowing to cut down in movement, distance and time, resulting in **higher efficiency and productivity**. This goal has been met because we've minimised the driving distances in this simulation of the 207 UM's (scope) with a substantial **50%** and **decreased the travel time with 26%**. These improvements can be translated into fulltime equivalent operators (38h). We only need 0,54 FTE instead of 0,73 FTE for this simulation of 200 UM's. That's **26% less FTE**.

Finally the new lay-out with the inbound buffer and traffic rules allow for a better flow to **remove bottlenecks**. This new workflow could be implemented almost immediately after implementing the shared data platform.

4 High-tech Solution for Cross-dock Optimization

4.1 Optimizing warehouse by robotizing

Data generation will also be applied for warehouse optimization. Operators will be needed to (un)load; we opt for a robotization using Automated Guided Vehicles (AGV).

4.2 Why AGV?

Using AGVs eliminates nearly all operator handling inside the warehouse, thus reducing **labor costs.** This situation will also increase safety as he AGVs have sensors detecting possible obstacles and they adjust speed accordingly. Their gentle handling of goods will result in less to no more damaged goods. Finally, AGVs sort goods automatically, allowing the operator to put goods away **more efficiently**. By using AGV's we will also **reduce mistakes to 0%.** because they will do exactly what our automatic system says.

Figure 17 AGV

The AGV picture to the right is an example of the AGVs we prefer. The pallets in the warehouse need to be put on racks, allowing the AGV's to go underneath and transport them to their designated location, before starting the next task. If no tasks need to be done, they go to the AGV stand-by zone.

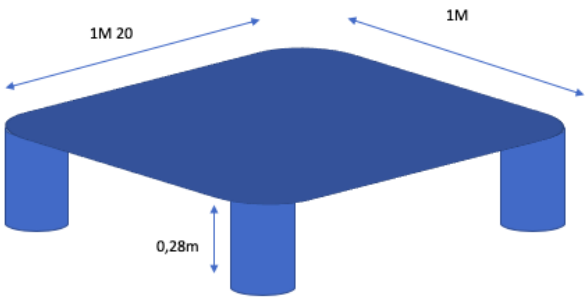


Figure 18 Pallet rack

The pallet rack illustration is an example of the racks that could be used to stack pallets on. The AGV's can go under them and take them to the place directed. They will have a layer of grip on top, so the pallets/goods won't slip.

The rack storing machine positioned like in the picture, will be used to store our racks. Each machine can store 25 racks. The machine can lower 1 rack while holding the other 24 so the AGV can take the 1 rack to handle the next UM.

Figure 19 Rack storing

4.3 TO-BE AGV simulator

Time calculations in seconds		
Constants	**Forklift**	**AGV**
Arriving inbound and grabbing pallet on forklift	10	0
Acceleration	5	5
Turn	3	3
Turn	3	3
Put pallet down and turn around	15	5
Turn	3	3
Turn	3	3
	42	**22**

Variable	Forklift	AGV
Speed in m/s	2,2	2
Average operator waste	2	0

Rest Surcharge in %

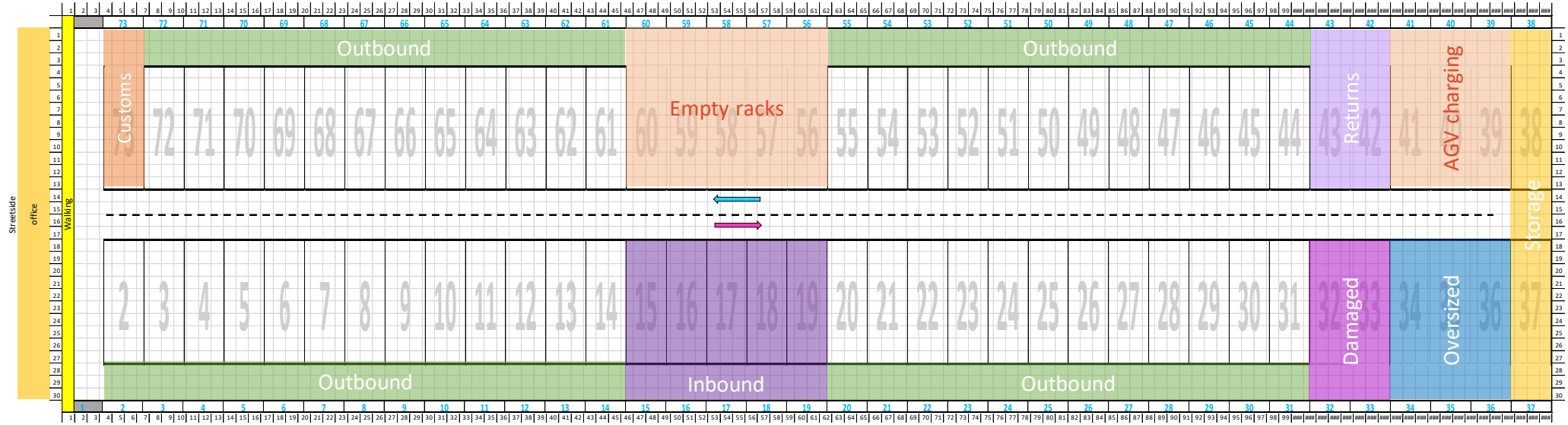
Be-ting in kg	ca. 90° gebukt	ca. 45° gebukt	achterover, handen boven hoofd	45°- 90° draaiend	
					
0 - 1	23	16	20	8	6
1 – 3	24	17	21	9	7
3 – 6	26	19	23	10	9
6- 10	28	21	25	12	10
10 - 15	30	23	27	14	12

File: Crossdocking 5 sim.xlsx

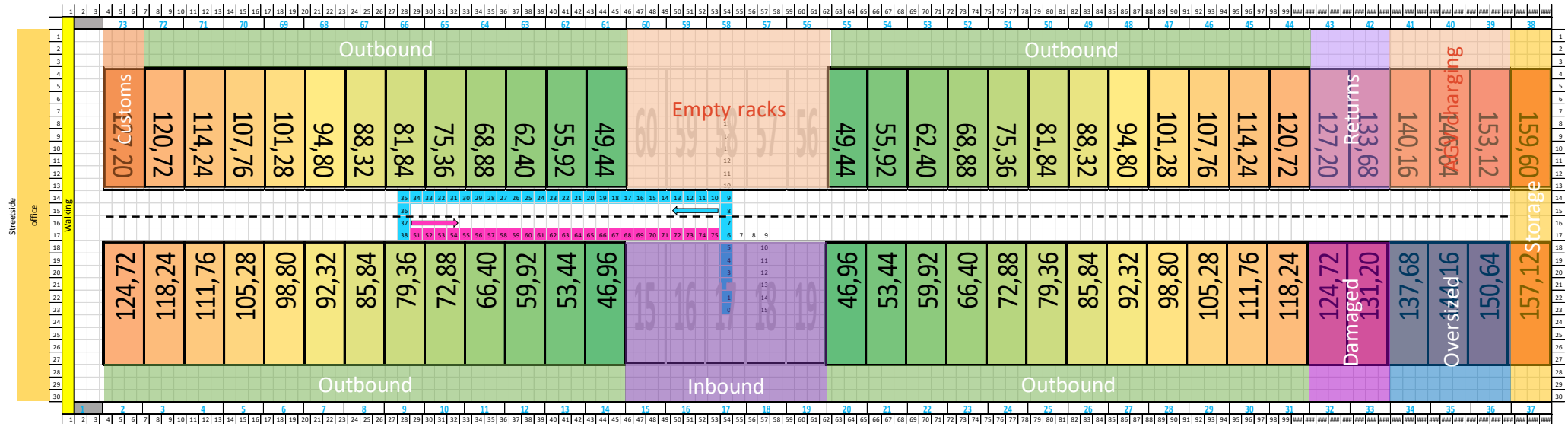
This page shows the **simulator** of the TO-BE AGV that runs in the background of the warehouse map. It allocates the UM's to the closest dock-lane to have a **minimum of travel time and distance** for the total amount of UM's.

TO-BE AGV		3.086,40	3.106,40	5.854,96	4.269,48			207,00	11.358,48	10.233,24
dock-lane nr.	Kind	inb-to dock (meter)	return (meter)	full cycle (meter)	full cycle time (seconds)	allocation order	Allocation	UM's	travelled (meters)	travelled time (seconds)
1	Entrance									
2	Outbound	64,36	60,36	124,72	84,36	49	0	0	-	-
3	Outbound	61,12	57,12	118,24	81,12	45	0	0	-	-
4	Outbound	57,88	53,88	111,76	77,88	41	0	0	-	-
5	Outbound	54,64	50,64	105,28	74,64	37	0	0	-	-
6	Outbound	51,4	47,4	98,80	71,40	33	0	0	-	-
7	Outbound	48,16	44,16	92,32	68,16	29	0	0	-	-
8	Outbound	44,92	40,92	85,84	64,92	25	0	0	-	-
9	Outbound	41,68	37,68	79,36	61,68	21	PRT-4	1	79,36	61,68
10	Outbound	38,44	34,44	72,88	58,44	17	DNK-8	1	72,88	58,44
11	Outbound	35,2	31,2	66,40	55,20	13	BEL-3	5	332,00	276,00
12	Outbound	31,96	27,96	59,92	51,96	9	BEL-7	24	1.438,08	1.247,04
13	Outbound	28,72	24,72	53,44	48,72	5	BEL-2	24	1.282,56	1.169,28
14	Outbound	25,48	21,48	46,96	45,48	1	BEL-1	24	1.127,04	1.091,52
15	Inbound	22,24	18,24							
16	Inbound	19	15							
17	Inbound									
18	Inbound	15	19							
19	Inbound	18,24	22,24							
20	Outbound	21,48	25,48	46,96	45,48	2	BEL-1	16	751,36	727,68
21	Outbound	24,72	28,72	53,44	48,72	6	BEL-2	10	534,40	487,20
22	Outbound	27,96	31,96	59,92	51,96	10	BEL-7	1	59,92	51,96
23	Outbound	31,2	35,2	66,40	55,20	14	BEL-5	4	265,60	220,80
24	Outbound	34,44	38,44	72,88	58,44	18	FRA-0	1	72,88	58,44
25	Outbound	37,68	41,68	79,36	61,68	22	0	0	-	-
26	Outbound	40,92	44,92	85,84	64,92	26	0	0	-	-
27	Outbound	44,16	48,16	92,32	68,16	30	0	0	-	-
28	Outbound	47,4	51,4	98,80	71,40	34	0	0	-	-
29	Outbound	50,64	54,64	105,28	74,64	38	0	0	-	-
30	Outbound	53,88	57,88	111,76	77,88	42	0	0	-	-
31	Outbound	57,12	61,12	118,24	81,12	46	0	0	-	-
32	Damaged	60,36	64,36	124,72	84,36					
33	Damaged	63,6	67,6	131,20	87,60					
34	Oversized	66,84	70,84	137,68	90,84					
35	Oversized	70,08	74,08	144,16	94,08					
36	Oversized	73,32	77,32	150,64	97,32					
37	storage	76,56	80,56	157,12	100,56					
38	storage	79,8	79,8	159,60	101,80					
39	AGV charge	76,56	76,56	153,12	98,56					
40	AGV charge	73,32	73,32	146,64	95,32					
41	AGV charge	70,08	70,08	140,16	92,08					
42	Returns	66,84	66,84	133,68	88,84					
43	Returns	63,6	63,6	127,20	85,60					
44	Outbound	60,36	60,36	120,72	82,36	47	0	0	-	-
45	Outbound	57,12	57,12	114,24	79,12	43	0	0	-	-
46	Outbound	53,88	53,88	107,76	75,88	39	0	0	-	-
47	Outbound	50,64	50,64	101,28	72,64	35	0	0	-	-
48	Outbound	47,4	47,4	94,80	69,40	31	0	0	-	-
49	Outbound	44,16	44,16	88,32	66,16	27	0	0	-	-
50	Outbound	40,92	40,92	81,84	62,92	23	0	0	-	-
51	Outbound	37,68	37,68	75,36	59,68	19	FRA-5	1	75,36	59,68
52	Outbound	34,44	34,44	68,88	56,44	15	DEU-5	1	68,88	56,44
53	Outbound	31,2	31,2	62,40	53,20	11	BEL-6	14	873,60	744,80
54	Outbound	27,96	27,96	55,92	49,96	7	BEL-9	24	1.342,08	1.199,04
55	Outbound	24,72	24,72	49,44	46,72	3	BEL-8	24	1.186,56	1.121,28
56	AGV racks	21,48	21,48							
57	AGV racks	18,24	18,24							
58	AGV racks	15	15							
59	AGV racks	18,24	18,24							
60	AGV racks	21,48	21,48							
61	Outbound	24,72	24,72	49,44	46,72	4	BEL-8	14	692,16	654,08
62	Outbound	27,96	27,96	55,92	49,96	8	BEL-9	6	335,52	299,76
63	Outbound	31,2	31,2	62,40	53,20	12	BEL-4	10	624,00	532,00
64	Outbound	34,44	34,44	68,88	56,44	16	DEU-8	1	68,88	56,44
65	Outbound	37,68	37,68	75,36	59,68	20	FRA-9	1	75,36	59,68
66	Outbound	40,92	40,92	81,84	62,92	24	0	0	-	-
67	Outbound	44,16	44,16	88,32	66,16	28	0	0	-	-
68	Outbound	47,4	47,4	94,80	69,40	32	0	0	-	-
69	Outbound	50,64	50,64	101,28	72,64	36	0	0	-	-
70	Outbound	53,88	53,88	107,76	75,88	40	0	0	-	-
71	Outbound	57,12	57,12	114,24	79,12	44	0	0	-	-
72	Outbound	60,36	60,36	120,72	82,36	48	0	0	-	-
73	Customs	63,6	63,6	127,20	85,60					

4.4 TO-BE AGV warehouse map

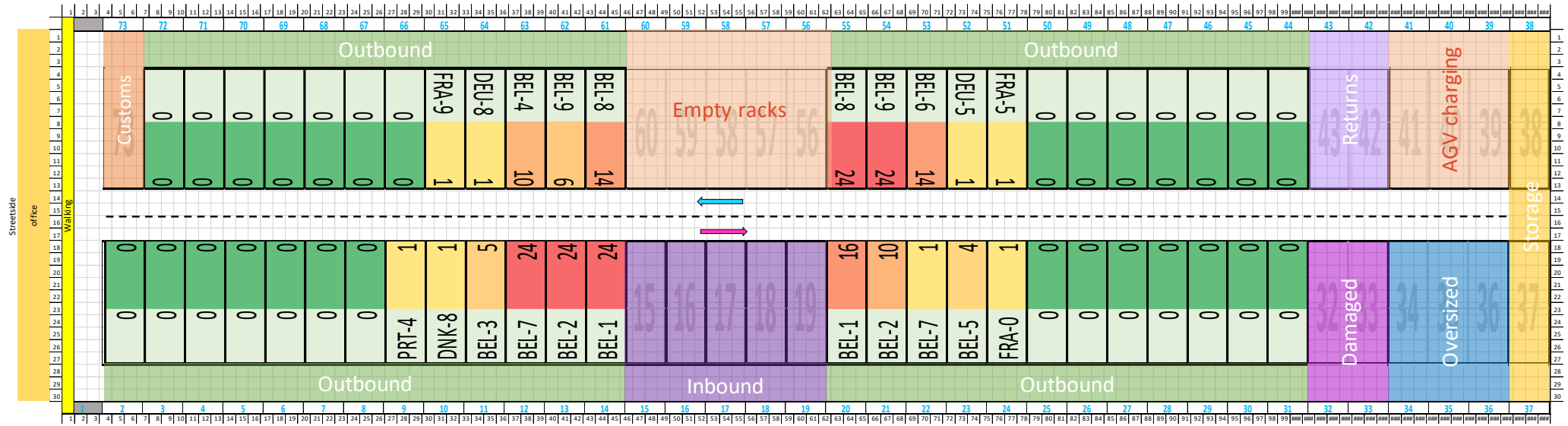


Scale: 1 cube = 1 meter by 1 meter. All drawn in scale.



TO BE AGV driving distance heatmap: full cycle (leaving and returning) in meters from centre of unloading to centre of dock-lane.

4.5 TO-BE AGV simulation warehouse map



Empty rack zone

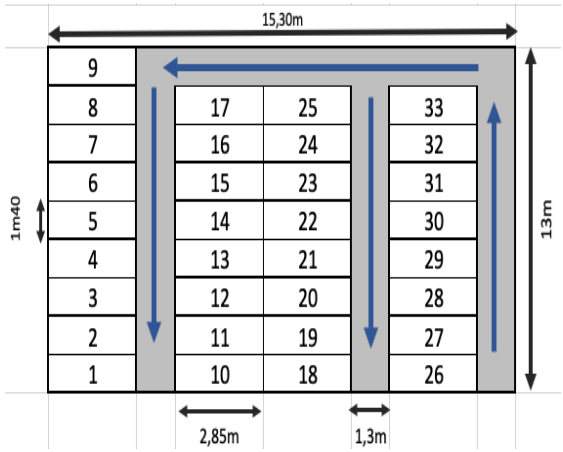


Figure 20 Empty rack zone

TO-BE AGV on 7/08/2018 of 207 UM's (scope)

After running the simulator with the **Variable Dock-lane System and the AGV implementation** you see the same huge difference. The same UM's are being put as close as possible to the inbound zone to minimise the distance.

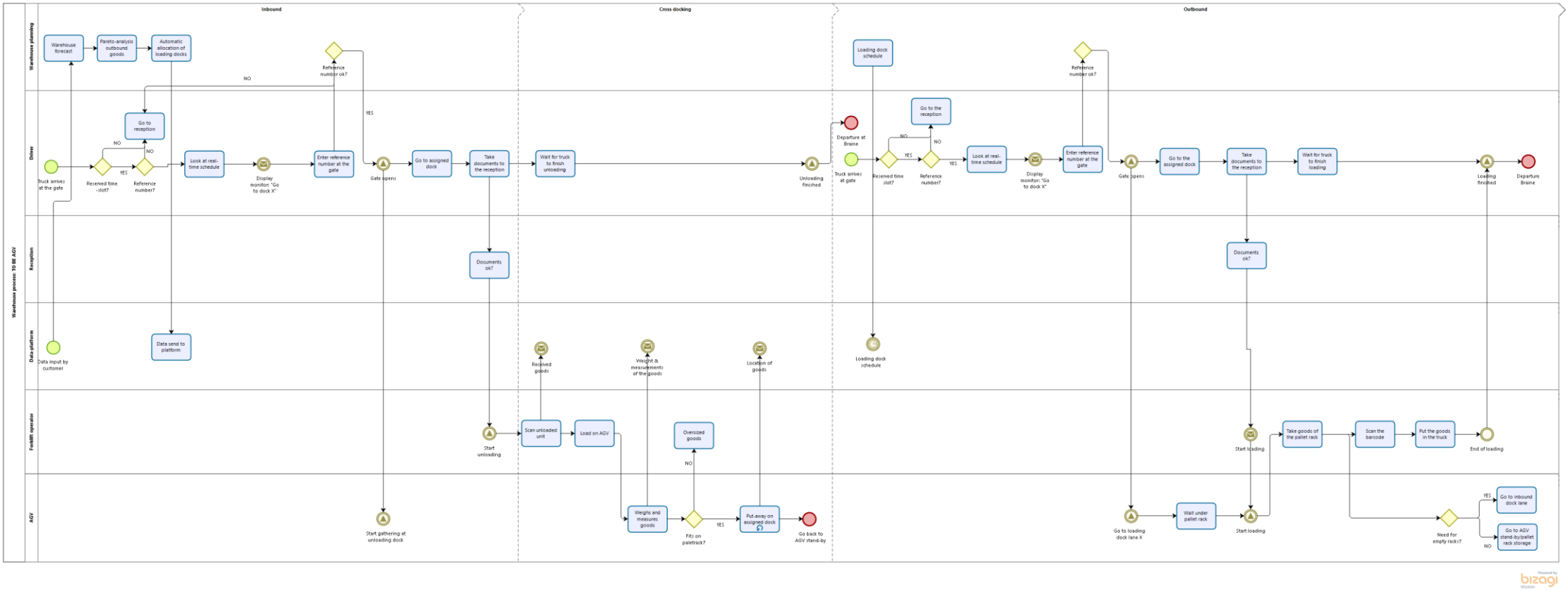
As before, the colour indicates when a dock-lane is nearly full or not. The max capacity is indicated with a red 24. Example: dock-lane 10 has 1 UM going to DEU-5.

Doing the same job with substantial less distance and in much less time will result in a higher productivity.

The empty rack zone picture shows how we would sort the empty rack zone with the machines shown in title 4.5.

File: Crossdocking 5 sim.xlsx

4.6 TO-BE AGV workflow map



This is an illustration of how we think the process will be done with our AGV system.

4.7 TO-BE AGV workflow process

4.7.1 Inbound

- Subcontractors make a reservation to load/unload.
- This reservation gives the driver a reference number, necessary to open the gate and enter the GEFCO site.
- Based on the data-input from our customer (when making the reservation), a forecast can be made on how many goods will be present in the warehouse at a specific moment.
- Using a pareto-analysis, the system will allocate the various routes to the docks.

4.7.2 Cross docking

- When the reference number is okayed, and the gate opens, the AGVs gather at that particular (un)loading dock.
- The truck is unloaded by the operators. The goods are taken out of the truck and put on the pallet racks on top of the AGVs "waiting" on the dock.
- The AGV weights and measures the goods and puts them on the docks assigned by the system.
- If the goods are oversized and don't fit on the pallet racks, they must be moved to the "oversized"-zone in the warehouse by forklift.
- When the AGVs have finished unloading, they go back to the AGV stand-by zone.

4.7.3 Outbound

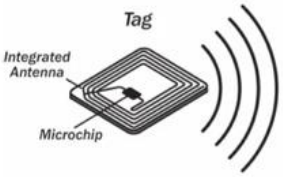
- The process for trucks is the same as in the inbound flow
- When the gate opens, it signals the AGV's to move to the loading dock and wait for the loading signal.
- When the loading signal is given, the operator starts taking the goods from the pallet racks. The AGVs take the empty racks to:
    - An unloading dock (when needed there)
    - The pallet rack storage
- Meanwhile, on the loading dock lane, other AGVs move the goods closer to the dock gate so the goods next to be loaded are ready for the operator.

4.8 Inbound

Most of the incoming goods are pallets. Sometimes, however, goods still need to be palletized allowing for AGV handling. Pallets need RFID tag in order to communicate with the AGVs.

4.8.1 From label to RFID

The goods entering the warehouse will all be individually labelled with their data. The unloading operator scans the goods. Every transporting rack has an RFID tag. Before stacking a pallet on a rack, the operator scans both pallet and rack to link them. and allow them to communicate, informing the AGV of the pallet's destination and dock.



4.8.2 invoicing

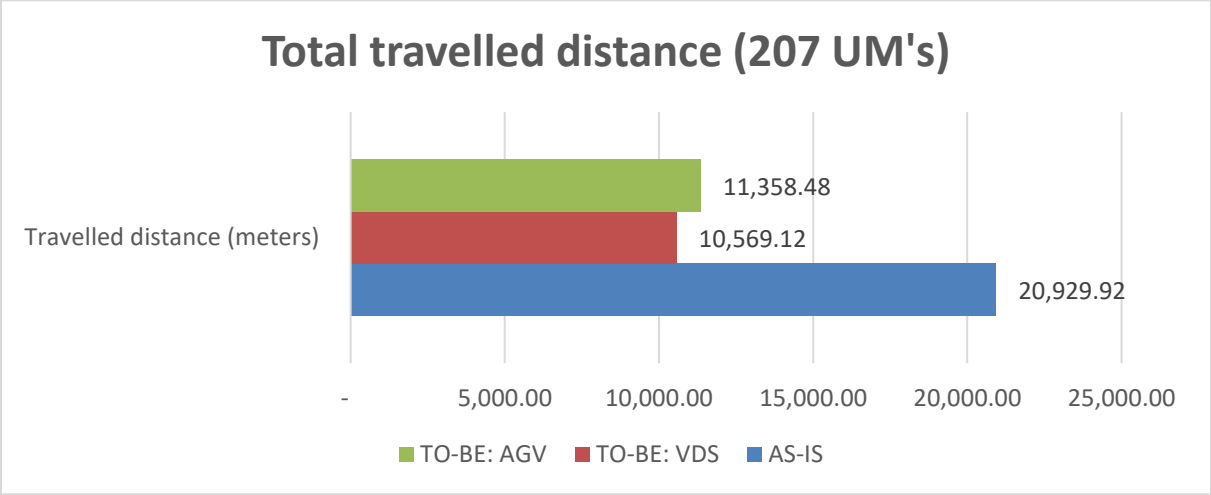
Upon entering the warehouse, the goods go through a **volume scanning** to determine exact measurements of goods/pallets. These are added to the RFID tag. While handling the goods, the AGVs also weighs them and again store this data in the RFID tag. This entire process allows for more accurate invoicing.

4.9 Outbound dock-lane operations

Sorting is a one most difficult tasks in cross-docking. The AGV system will solve this.

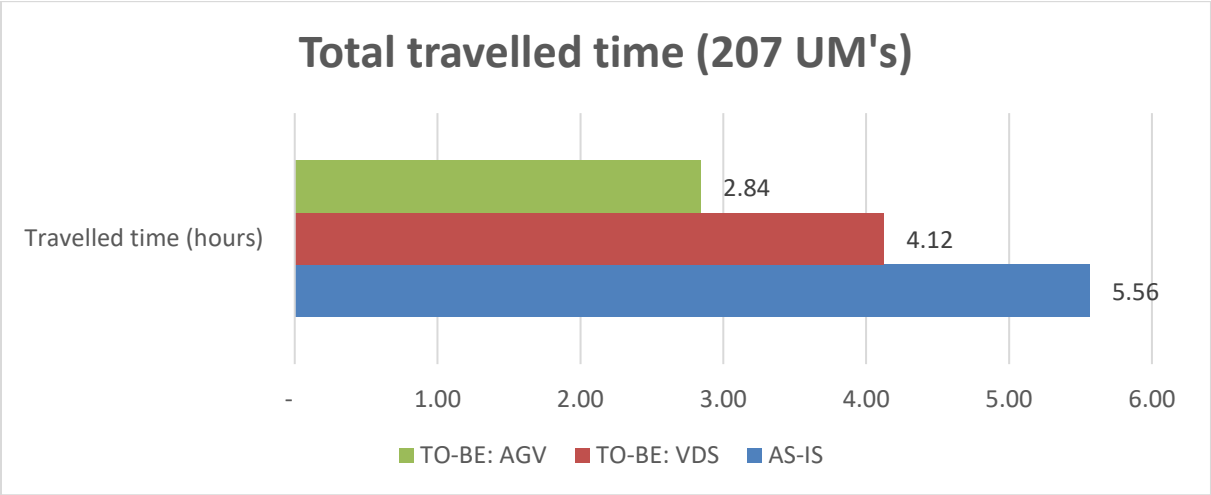
AGVs automatically put away pallets on the right lane, disregarding the sequence of the coming outbound truck in this phase. When all pallets are in place, the AGVs sort every lane until all pallets are positioned correctly and in the right order. Next, operators can place the pallets in the trucks, related to the smart routes that we created.

4.10 AGV results

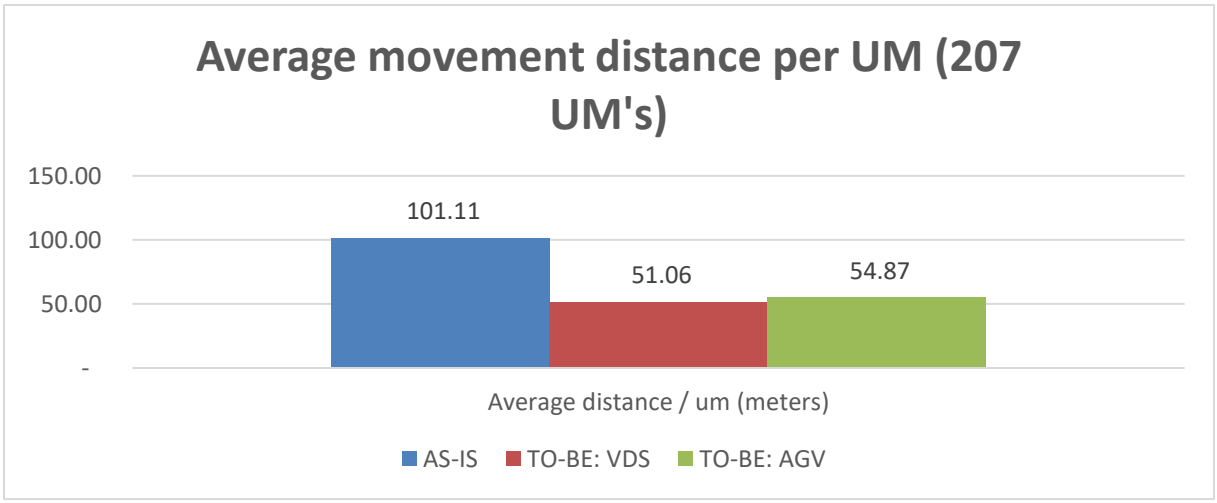


The **travelled distance is 45% lower** in the TO BE AGV. From 20,9 km to 11,4 km.

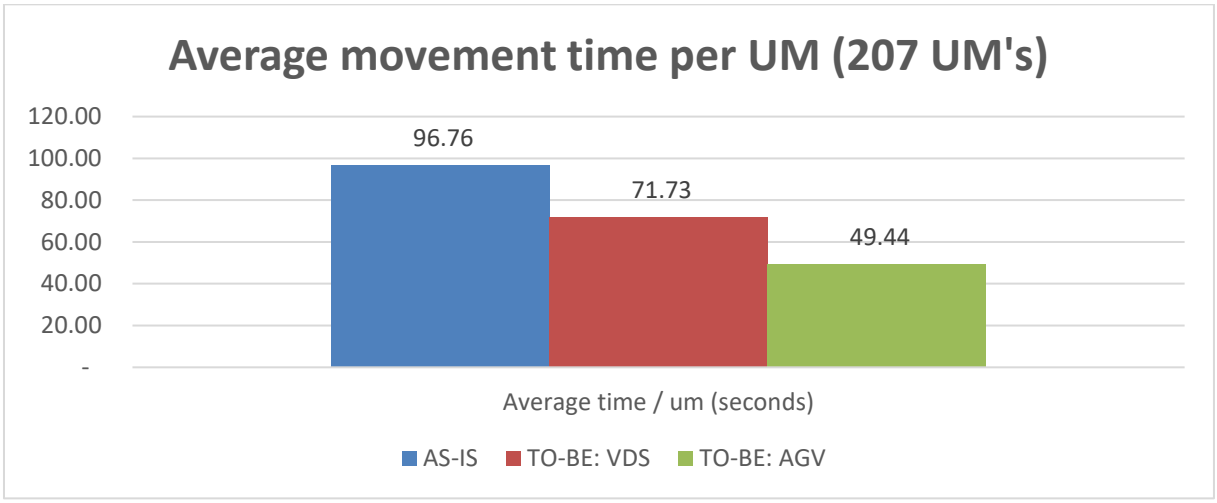
It is to be expected that we cover slightly more distance than the TO-BE solution as we are using the closest locations for the **empty rack zone** in order to avoid a busy middle lane. Because AGVs are robots, however, they are not affected by waste time or delays when starting a movement operation. They are always in place.



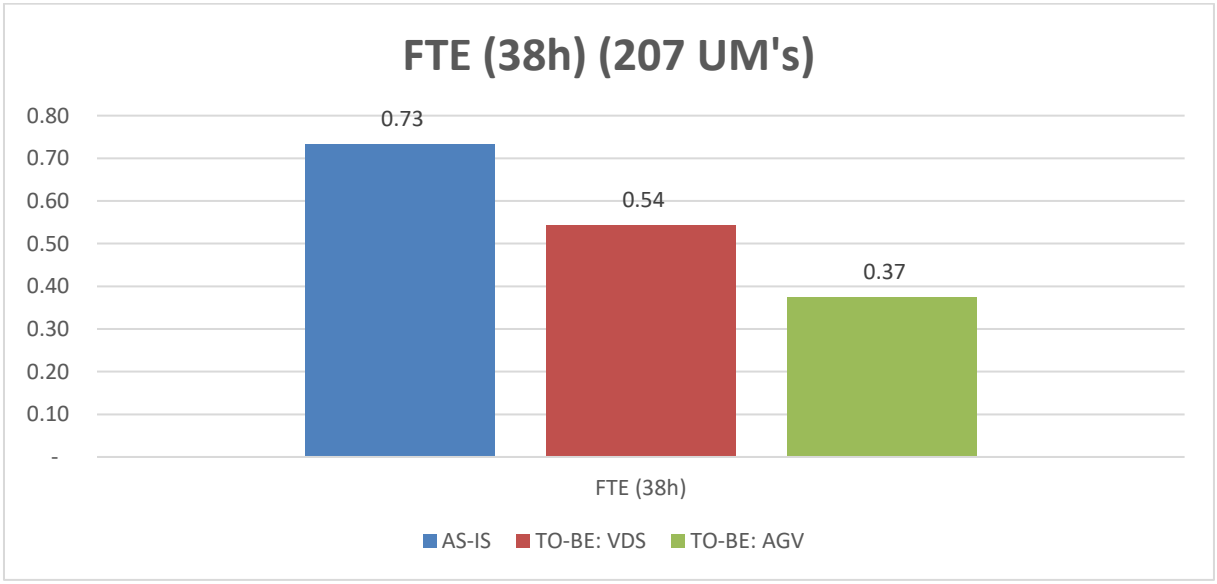
The **travelled time is decreased with 49%** in the TO-BE AGV. From 5,56 hours to 2,84 hours!



The **average movement distance per UM** of the TO-BE AGV is **49% shorter** than the AS-IS!



The **average movement time per UM** is **49% lower** than the AS-IS, 50 seconds instead of 97 seconds!

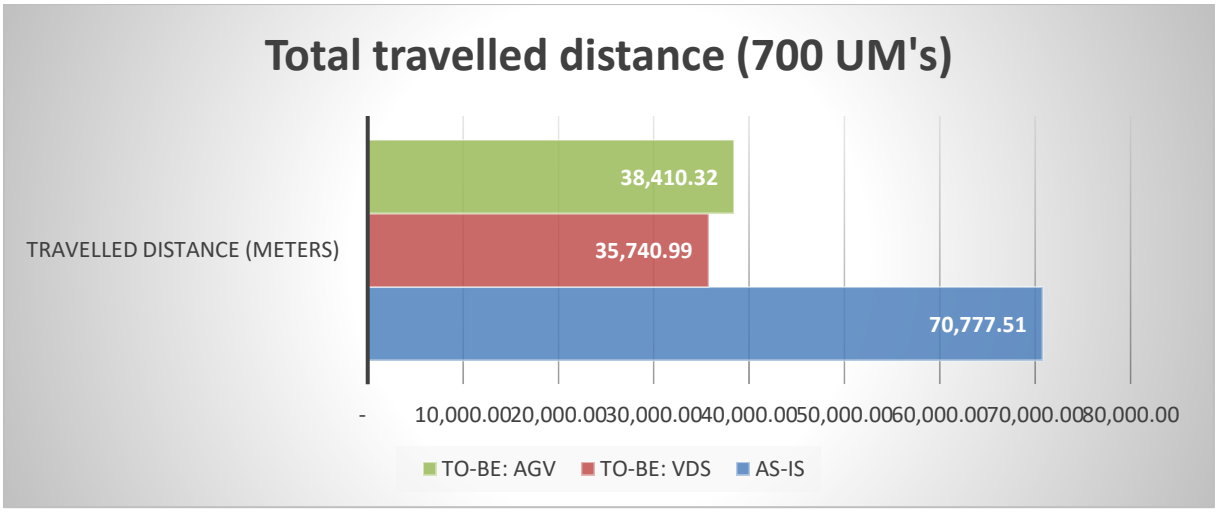


When we change the worked time to full time equivalent operators with 38 hours a week contract, we only need 0,37 FTE instead of 0,73 FTE for this simulation of 200 UM's. That's **50% less FT!**

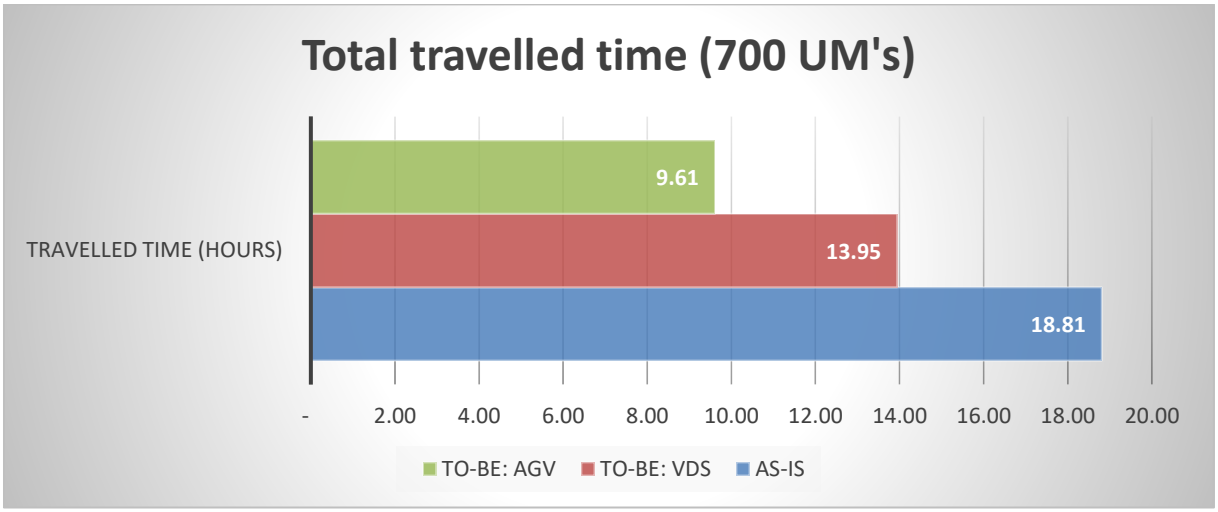
When we try to get a more realistic view of the situation and **extrapolate** our scope of 207 UM's **to 700 UM's** we get the following numbers:

Extrapolate	UM's	Travelled distance (meters)	Travelled time (seconds)	Travelled time (hours)	Average distance / um (meters)	Average time / um (seconds)	FTE (38h)	Travelled distance %	Travelled time %
AS-IS	700	70.777,51	67.728,75	18,81	101,11	96,76	2,48	100%	100%
TO-BE	700	35.740,99	50.210,49	13,95	51,06	71,73	1,84	50%	74%
AGV	700	38.410,32	34.605,16	9,61	54,87	49,44	1,26	54%	51%

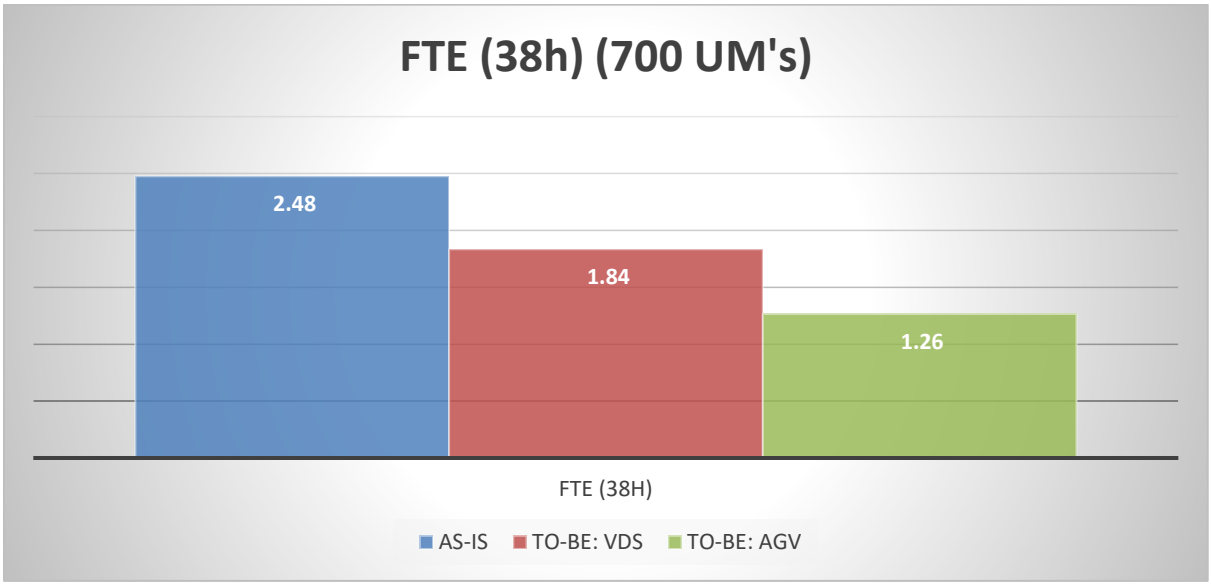
Figure 21 Extrapolation



The **travelled distance is 45% lower**.

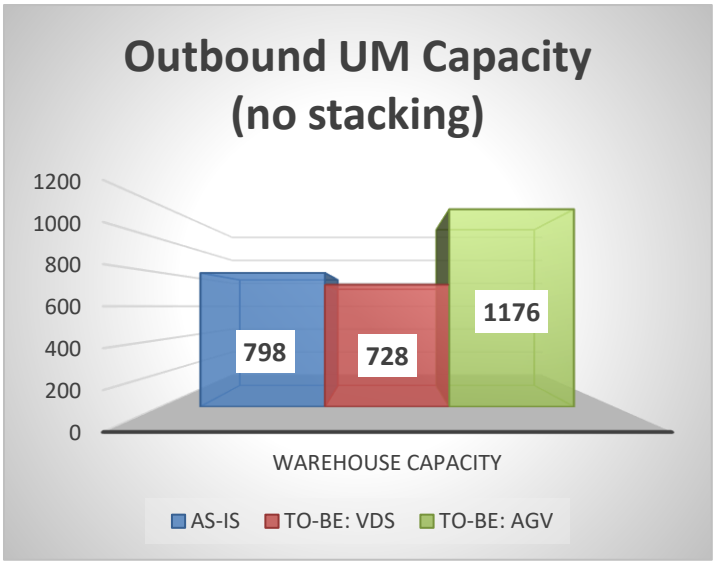


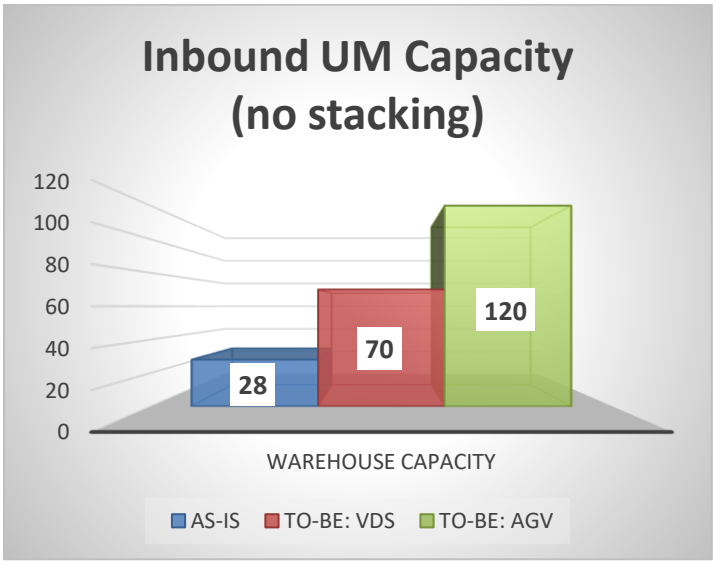
The **travelled time is decreased with 49%.**

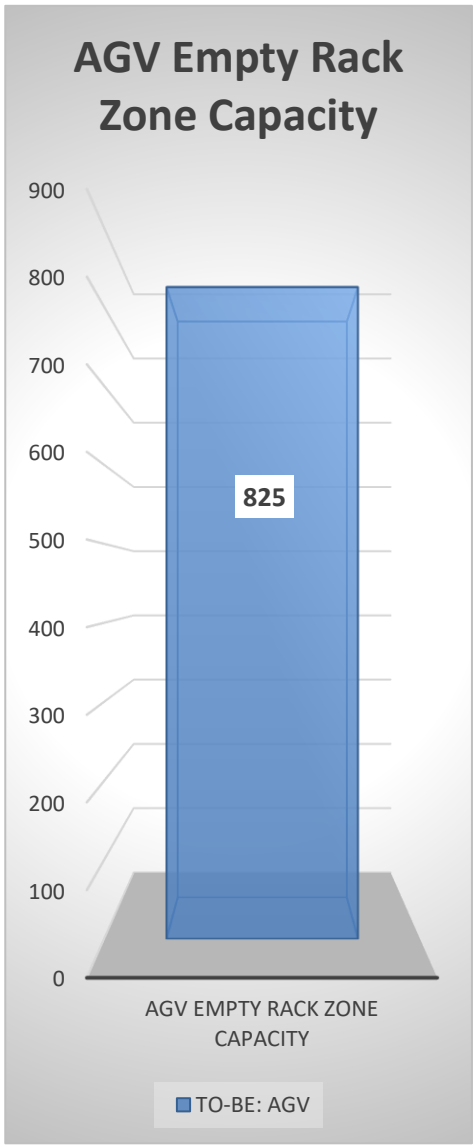


When we change the worked time to full time equivalent operators with 38 hours a week contract, we only need 1,26 FTE instead of 2,48 FTE for this extrapolation of 700 UM's. That's **50% less FTE!**

After **extrapolation** of the initial 207 UMs simulation on 7/08/2018, the AGV cross-docking operations would work **twice as fast** than the AS-IS and AGV's do the work of **3 Full Time Equivalents.**







For the outbound operations we have an **increased total capacity to 1176 UM's** in the TO-BE AGV.

For the inbound operations we have a total capacity of 120 UM's. **4,3 times more UM capacity** for the inbound allows for a better management of peak hours.

The Empty rack zone allows a capacity of 825 UM's.

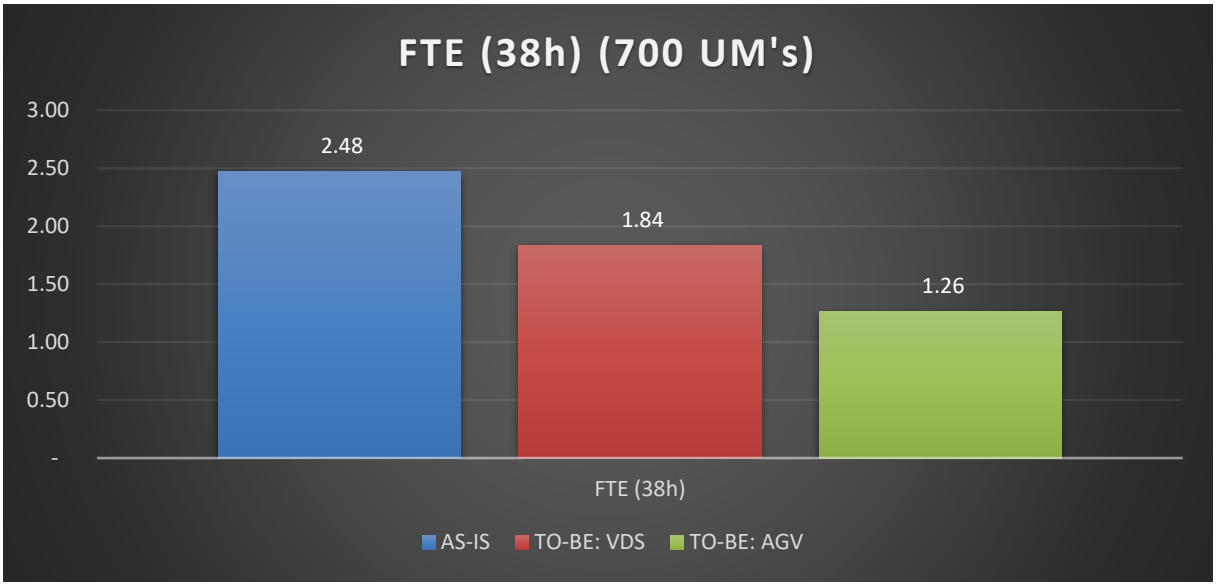
File: Crossdocking 5 result.xlsx

4.11 AGV conclusion

It was the intention to further optimize the warehouse operations with the introduction of AGV's and the VDS technology. This resulted in a higher **decrease of 49% travel time** instead of previous 26% decrease. The travelled time for the AS-IS amounts to 5,21 hours, for the TO-BE 3,95 hours and for TO-BE AGV only 2,84 hours. This means that our operations are running even faster than before and create the solution we've been looking for.

We will be able to handle 60 UM's/minute with one AGV. In that way we can reduce the amount of 3 FTE operators to 1,5 FTE operators. That will reduce our labour cost with 50%. With our solution it will be possible to handle 825 UM's at the same time. Our AGV's will also solve the sorting problem. Which is one of the biggest difficulties in cross-docking.

After **extrapolation** of the initial 207 UMs simulation on 7/08/2018, the AGV cross-docking operations would work **twice as fast** than the AS-IS and AGV's do the work of **3 Full Time Equivalents.**



5 Additional Improvements

Quality improvement is important for every company. It helps you to collect and analyze data. It also focuses on identifying sub-optimal processes in the business to improve them and reduce the defects in general. We will quickly show you a few **lean tools** that might come in handy.

5.1 Improvement board

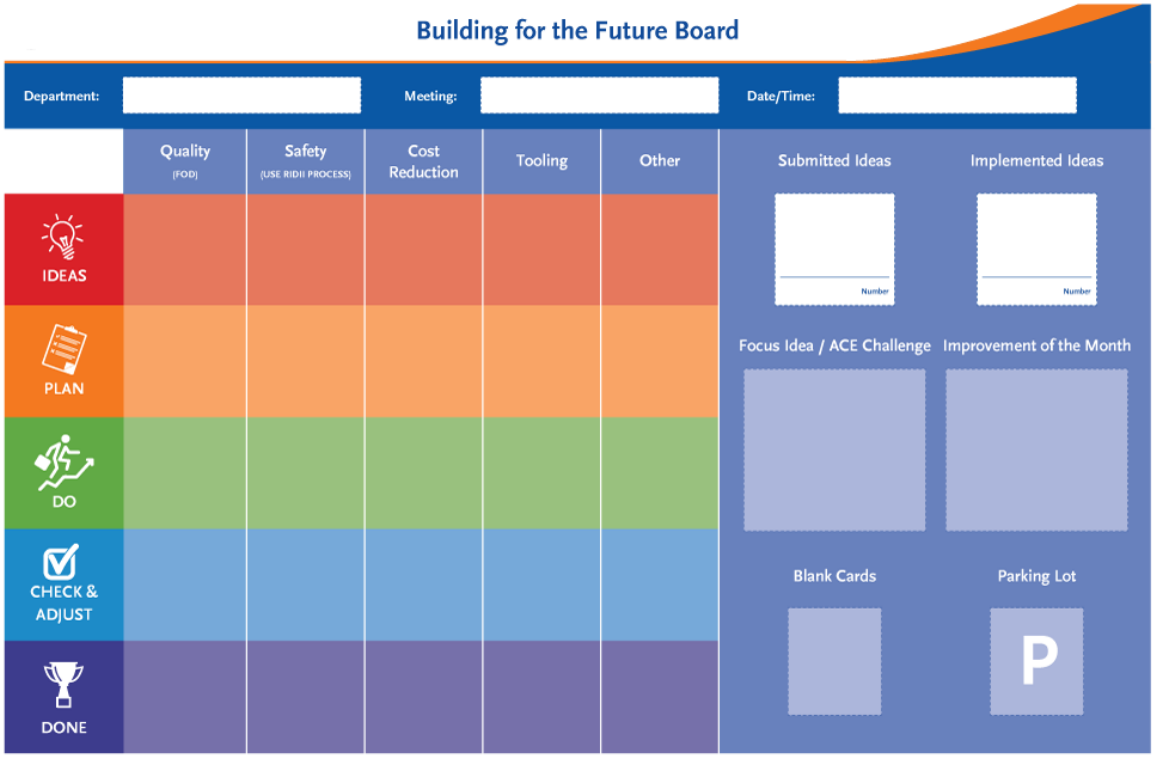


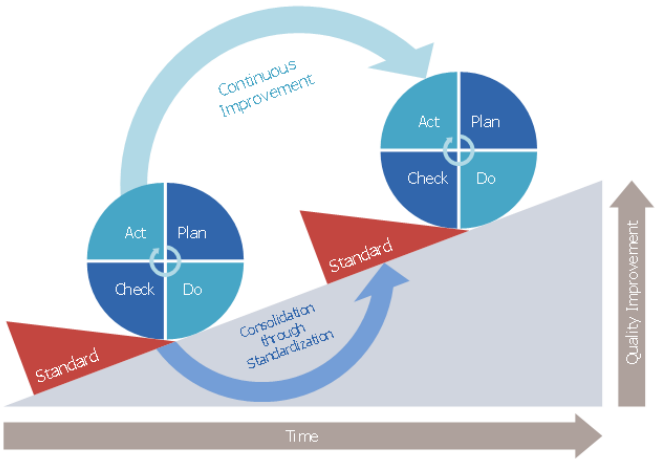
Figure 22 KPI Boards | Visual Workplace, Inc.. (n.d.). Retrieved November 22, 2018, from http://www.visualworkplaceinc.com/continuous-improvement-resources/kpi-boards/

An **improvement board** might be a useful tool to facilitate the execution of improvements. The board is used to communicate the improvement procedure to employees with visualizations.

During the floor meetings, all **employees** discuss everything that is displayed on the board and bring forth suggestions, opinions and thoughts. This new input is pushed through to the managers or team leaders who can **translate these ideas into actions**.

Employees solve often quicker smaller problems because they are confronted with these on a daily basis. The only thing they need, is the time and opportunity to **voice ideas**. Managers should be involved to inspire employees to use the improvement board.

5.2 PDCA



The Deming cycle or PDCA cycle, Plan-Do-Check-Act, is a method you should use to sustain your continuous improvements. Make every new implementation your new **standard**. This is the drive of your business culture.

Figure 23 PDCA Process. (n.d.). Retrieved November 21, 2018, from https://conceptdraw.com/a1739c4/preview/640

5.3 SOP

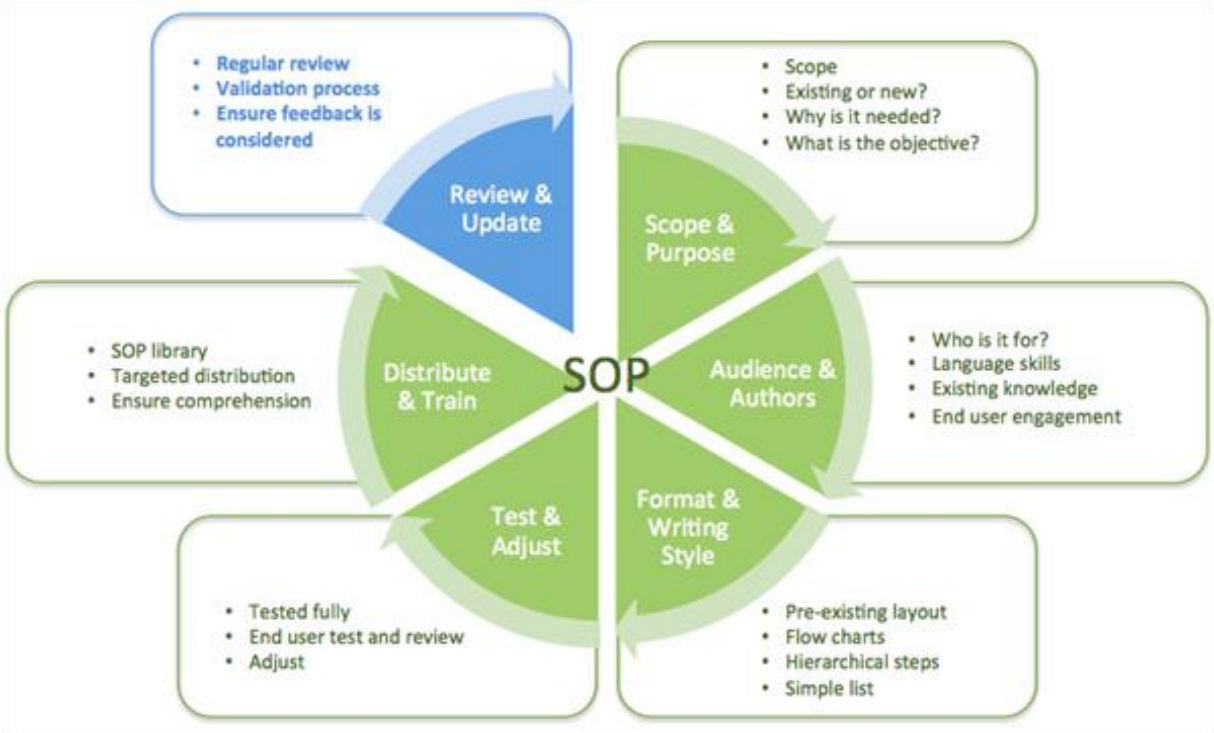


Figure 24 Standard Operating Procedures – A complete guide! – Scope and Purpose – Collaboris. (n.d.). Retrieved October 15, 2018, from https://www.collaboris.com/standard-operating-procedures-a-complete-guide-scope-and-purpose/

Standard Operating Procedures are detailed, written instructions on how to perform a routine business activity. They are easy to read, and they explain and document every detail of the process. The advantage of this illustration is that it provides a clear visual image and makes sure that you save space. It shows which method you have to pay attention to.

5.4 KPI's

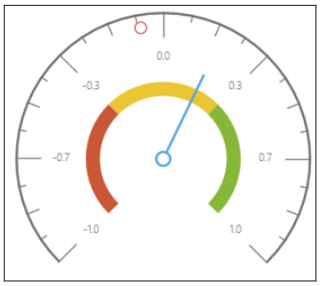


Figure 25 SSAS KPIs in BI Office. (2017, April 17). Retrieved November 22, 2018, from https://community.pyramidanalytics.com/t/k9tpy5/ssas-kpis-in-bi-office

Key Performance Indicators are measures to analyze the performance of the organization. These tell you how close you are to your **goals**. We will introduce a few KPI's at the end of this paper.

5.5 One-point lessons

One-point lessons can be written by **anyone** in the organization. However, it is best for operators and team leaders to write a one-point lesson and communicate this to their peers and employees. All one-point lessons should be kept in a central area which is easy to access by most teams and employees. The One Point Lesson can be about knowledge, issues or improvements. An example could be how to correctly park the forklift back in its parking space.

- It's a way to **train** people
- The "lesson" lasts 5-10 minutes.
- Explanation should be given by employees for employees
- The explanation fits on one sheet of paper
- The "lesson" is recorded

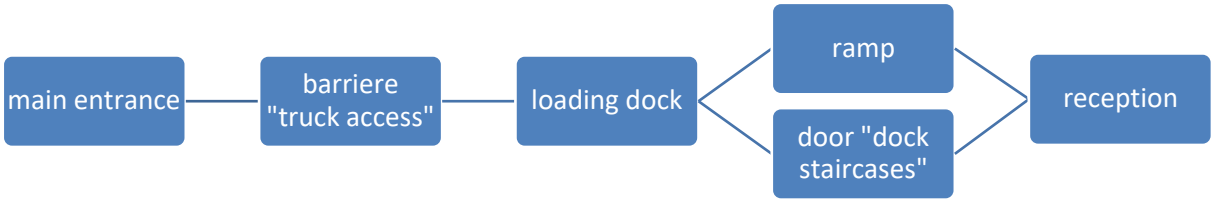
5.6 Conclusion

With a the implementation of lean tools and a **lean culture**, you can **continuously improve** your organisation. KPI's will allow you to follow-up on your goals and make changes when necessary. Most importantly, **listen to all employees** and encourage everyone to be heard.

6 Improving On-site Safety

A few small adaptations will make the site safer and more clearly for drivers. They will also allow for better **communication with the driver.**

6.1 Site access



6.2 Picture 2: gate “truck access”

Safety

- No parking on the grass
- Sign only drives in forward

6.3 Picture 3: door “truck staircases”

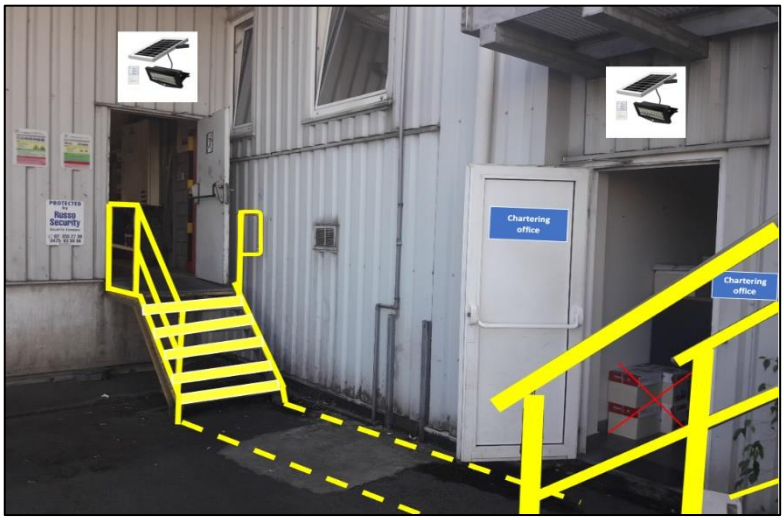
Clear communication

- Put signs in multiple languages

Safety

- Place a light with a motion sensor
- Repaint the railings of the staircases
- Replace safety signs

6.4 Picture 4: door “dock staircase (left) and chartering office entrance (right)”



Clear communication

- Put signs in multiple languages

Safety

- Place a light with a motion sensor
- Repaint the railings of the staircases
- Remove the boxes from the entrance
- Mark a walking area

6.5 Picture 5: ramp

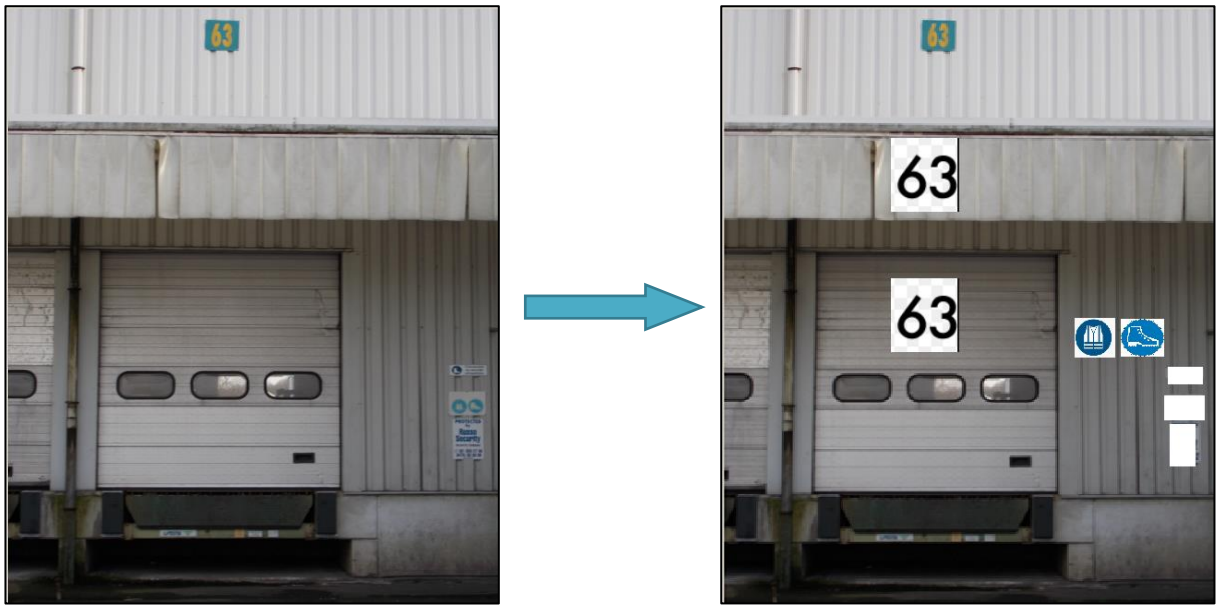
Clear communication

- Put signs in multiple languages
- Larger dock numbers

Safety

- Mark walking areas
- Mark crossings

6.6 Picture 8: dock-gate



Clear communication

- Larger dock numbers
- Replace safety signs

6.7 Extra attractiveness to drivers

On top of the improved communication and warehouse activities, GEFCO can improve drivers' experience by placing vending machines and provide sanitary facilities (toilets and showers). These vending machines can include pasta's or quick bites like noodles that the drivers can heat up in the cafeteria.

6.8 Conclusion

To make the site safer and clearer for drivers, put signs in multiple languages and mark walking areas. A few small changes could make a large impact.

7 Clear Communication with Drivers

7.1 Instruction manual

The instruction manual was too long for drivers to read. Making it shorter and clearer will entice drivers to read it and consequently know what is expected.

Instruction manual for drivers

LOADING
RECOGNITION OF GOODS
USE YOUR PDA TO FLASH BARCODES OF PARCELS DURING LOADING
You must CHECK:
- Presence of returnable packaging
- number corresponds with the (one on) the PDA

You must REPORT:
- All anomalies

END OF LOADING
- Analyse anomalies with GEFCO personnel
- Control and closure of the PDA tour by a dispatcher
- Retrieve the Tour Sheet edited by the Trucking service

Control and loading of goods
- Check the merchandise quantity with the documents. In case of filmed pallets only the number of pallets is taken into account
- Check that packages show a clear destination address
- In case of defective packaging, damaged or dangerous goods, you can refuse to take over goods
- Beforehand, call the trucking service manager for approval.

Problem with collection
Contact the trucking service and await instructions
Put this information on the collection slip, let the client sign and declare the event in the PDA in REAL TIME

RECEIPT (PERSONAL LIABILITY)
- Notify the recipient that there is a receipt BEFORE PRESENTING THE GOODS
- NEVER deliver without caching the amount of money indicated on the PDA
- Payment only cheque or immediate transfer
- If the consignee does not accept these payment terms, call trucking service

On your arrival at the agency
Follow the safety instructions
At any time of the day in case of doubt, problem of difficulty, call the trucking service at Braine l'Alleud : 0800 23 036

ORGANIZING YOUR ROUND
Documents
DO NOT DETERIORATE BARCODES:
Car letters
Request for collection
Other obligatory documents

Always check when you prepare your round:
Time of travel & weight limit
Local constraints

Pay attention to:
Delivery requirements & reservations
COD

LOADING DANGEROUS MATERIALS
Make sure to have an ADR kit before leaving
Check if the products are allowed
Doubt -> contact office for confirmation

REPORT DELIVERY UNLOADING
- Address incomplete/mislabelled
- Access impossible
  - ➔ Update the status of the shipment in Report delivery unloading

waybills (if necessary) with:
- Receipts
- Reserves
- Refusals
- Notice of passage

After docking and wedging your vehicle, head for warehouse
Return returnable packaging to be checked by a dock agent
Unload your vehicle in the presence of GEFCO personnel
Always ask GEFCO personnel to remove the vehicle from the dock

RESERVES - REFUSAL ▪ Reserves: recipient challenges goods/parcels' condition or quantity ▪ Declare the event corresponding to the reservation by the recipient on the PDA ▪ If you do not agree with the reservations expressed by the customer, add to PDA ▪ Open packages -> make inventory of the content in presence of recipient ▪ Take pictures using PDA ▪ Refusals: recipient refuses entire of part of delivery ▪ recipient should CLEARLY write his/her name and reason of refusal on PDA ▪ NEVER accept opening of a parcel by recipient before signature on PDA. **DELIVERY OF COLLECTION DOCUMENTS** Present to the office return driver all the documents in your possession Submit following items: ▪ Closing the tour in PDA ▪ Deliver collecting documents **SEE ADRESS** ▪ Address incomplete/mislabelled ▪ Access impossible ➔ Update status of shipment in PDA **CALLING CARD** Advice of notice of passage: recipient is absent during visit, or you cannot access his home Complete 2 parts of the YELLOW LABEL NOTICE OF PASSAGE ▪ Drop the large shutter into the recipient's mailbox ▪ Paste label on package ▪ Update the status of shipment in PDA	**DELIVERY** Go to the address on your PDA; if recipient is not present but you have another option validate with trucking service. If a third party accepts the goods, have him/her sign in his/her own name. Flash goods at place of delivery and fill in details in REAL TIME. **UNLOADING – EMARGEMENT** Recover ALL returnable packaging Refuse of return -> indicate reason in PDA Notify the trucking office if you see GEFCO PACKAGING at customer's place **Collection** Presentation at the customer Make sure that returnable packaging appears on documents and corresponds. Record any anomaly on the PDA Customer documents Retrieve the discount documents issued by client For shipment outside EU, collect required documents indicated on removal request

7.2 Communication conclusion

A shorter driver manual will be read by drivers. This would lead to better **communication** and fewer misunderstandings when both parties know what is expected.

8 Continuous Improvements with KPI's

8.1 On-time delivery

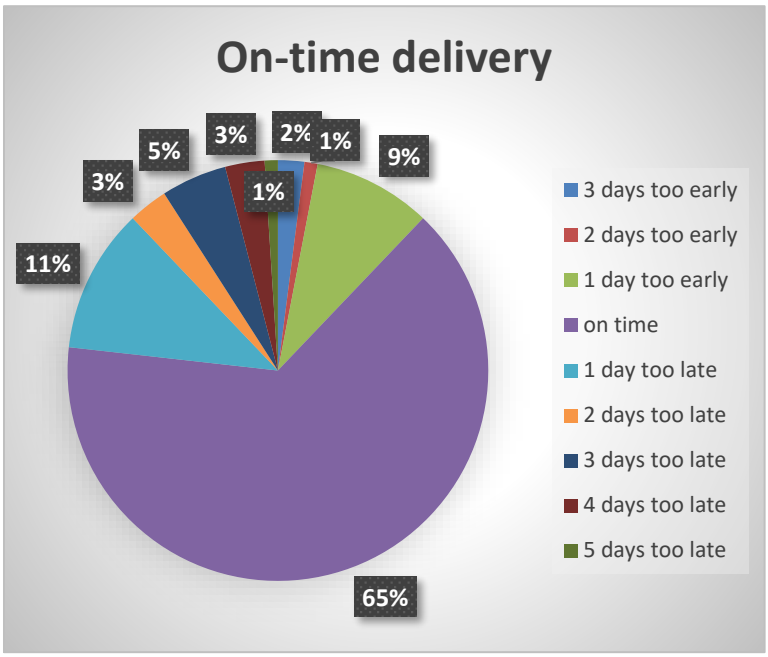


Chart: **when were goods delivered**

Only 64% of the goods get delivered on time. GEFCO needs to aim for 95%.

8.2 On-time collection

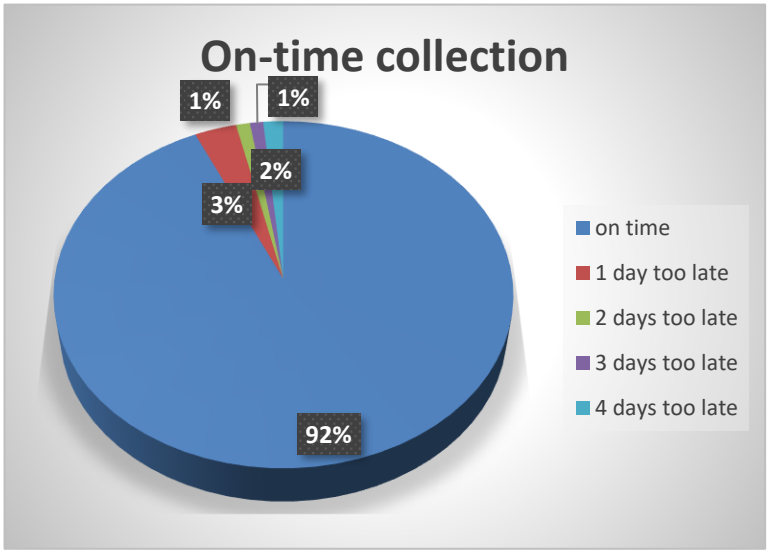


Chart: **when were goods collected**

Only 92% of the goods get collected on time. GEFCO needs to strive for 95%.

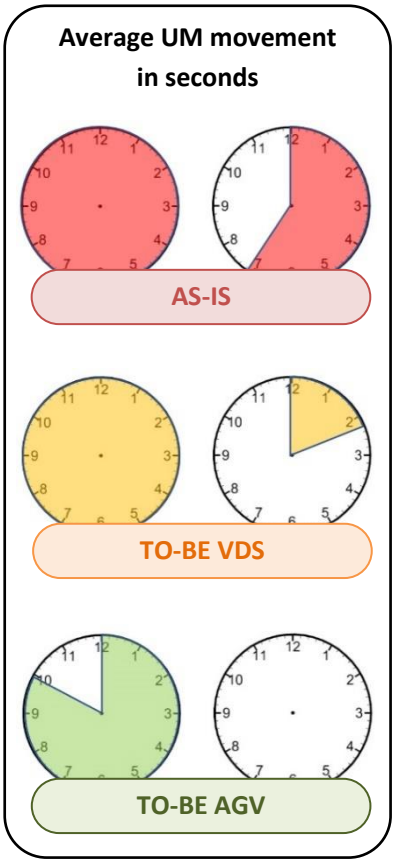
8.3 Safety

Safety KPI'S that GEFCO could focus on:

- How many drivers wear fluorescent jackets in the warehouse?
- How many drivers wear safety shoes in the warehouse?
- How many work-related accidents occur?

9 Conclusion

As promised, we offer you a great deal of improvement to your organization. To optimize the cross-dock operations we would first implement a data sharing platform with all partners. This will be crucial for our **physical handling** solutions. The data that will be generated, will allow us to create smart routes and a flexible dock system. The platform is beginning of the **communication** improvements between all parties in your supply chain.



To **optimize the cross-dock activities**, we designed two solutions that increase the **efficiency** and **productivity**.

First, we made a quick win implementation with the help of our Variable Dock-lane System. With the input of our data platform and the VDS, we realized a much higher efficiency. The average traveled distance per UM for the operators is decreased with **50%**. This also decreased the average travelled time per UM for the operators with **26%**. What means we can handle the same amount of UM's with less operators.

Our second fully automated high-tech solution will only require operators to (un)load the trucks. With the use of Automatic Guided Vehicles we will eliminate all manual handlings from inbound to outbound resulting in almost **no mistakes**. The robotized solution will use the same Variable Dock-lane System to optimize the flow of all AGV's. The results show an average travelled distance per UM decrease of **50%** and a decrease of the average travelled time per UM of **50%**! You will be able to handle a **higher capacity** much less operator costs. This brings us back to the introduction of our time savings illustration. "Time is money!"

With the different improvement methods, tools and culture, you can continuously improve your business. The drivers and employees will be able to participate in the improvement process with their own ideas. With some small adjustments we can make the site at GEFCO **safer and clearer** for the drivers.

All these improvements result in the increase of GEFCO's **attractiveness** towards partners and employee's.