Supply Chain Simulation

We've created a supply chain simulation to test different ways of visualizing time and performance.

Supply Chain Stages

Order received

The supply chain starts with an order being received at a warehouse. These orders can come in at any time of day.

Order picked and packed

The order is then picked and packed in the warehouse. If the order is received out of business hours, this step occurs when the warehouse opens again (07:00).

Waiting until full-truck volume

Next, the warehouse waits until they have enough volume to ship an FTL. If the warehouse won't have enough volume, it will wait until the next day.

How long this takes is influenced by the carrier.

Order loaded

When there is enough volume, the order will be loaded on to the truck for delivery.

How long this takes is also influenced by the carrier.

Driving to customer

The delivery is then driven to the customer.

How long this takes is also influenced by the carrier.

Unloaded at customer

Last, the delivery is unloaded at the customer location. If the driver arrives outside of business hours, they wait until business hours to unload.

Total Orders	Total Carriers	Total Products	Total Customers
626 orders	5 carriers	1 product	1 customer

The Data

Below is an example of the data used in the dashboards for this analysis. We have timestamps of each event for each order. Following the first step (order received), every step has an **'actual duration'** and a **'value added duration'**.

Actual duration: the amount of time that elapsed from the completion of a step from the completion of the previous step.
Value added duration: the amount of time actually spent working on a step (excluding overnight waiting times).

Step	Carrier	Actual Duration (h)	Value Added Duration (h)	Time of Event
Order received	Carrier 1	Null	Null	8/05/2016 11:00:00
Order picked and packed	Carrier 1	0,275951354	0,275951354	8/05/2016 11:16:33
Waiting until full-truck volume	Carrier 1	0,717814026	0,717814026	8/05/2016 11:59:38
Order loaded	Carrier 1	0,327986632	0,327986632	8/05/2016 12:19:18
Driving to customer	Carrier 1	3,298720767	3,298720767	8/05/2016 15:37:14
Unloaded at customer	Carrier 1	0,237479936	0,237479936	8/05/2016 15:51:29

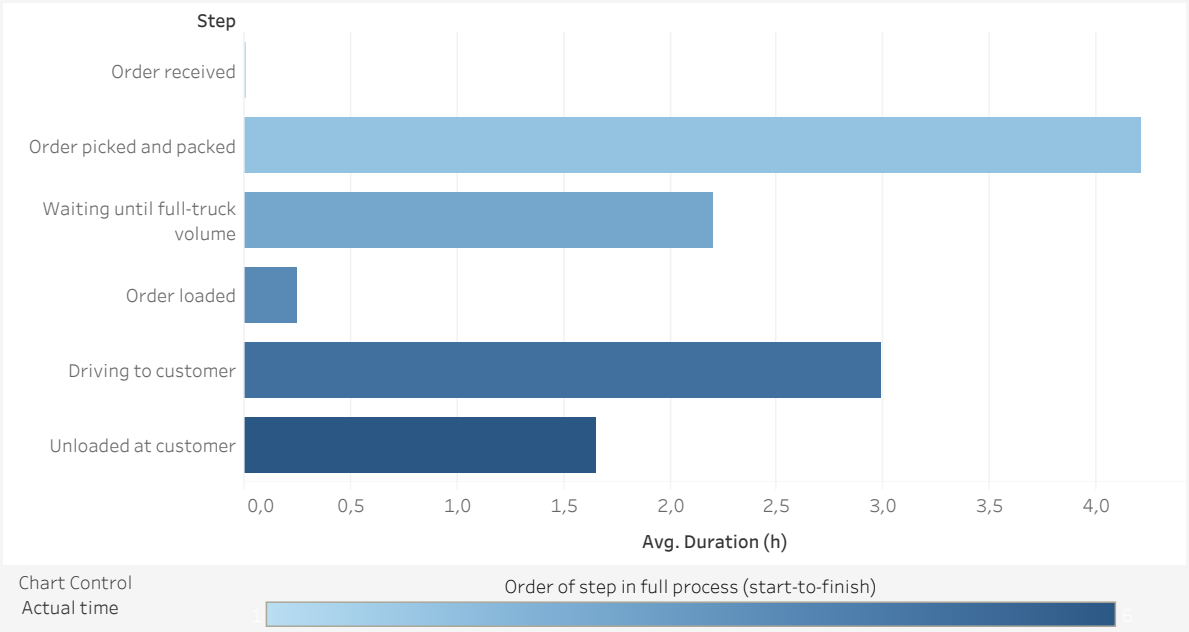
Supply Chain Simulation

First, how long does it take on average to complete an order?

Average Value Added Time	Average Actual Time
4,760 h	11,31 h

Second, how much of this time was spent on average on each step?

Using the "chart control" at the bottom will switch between value added time and actual time.



With the two figures and this single chart, we can already conclude two things:

One, more time is passing during orders than what is needed to execute them. (Actual vs value added time)

Two, the differences in time measures is coming from three steps: Order picked and packed, waiting for full-truck load volume, and unloaded at customer.

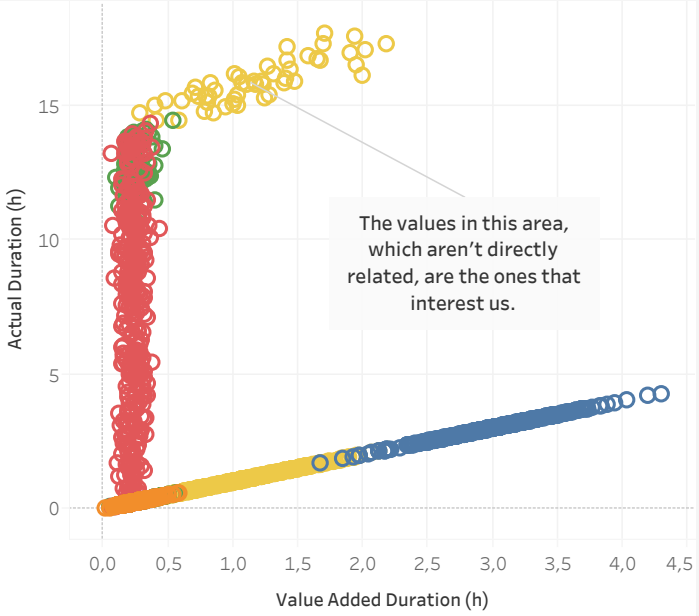
Supply Chain Simulation

Let's try to understand our insights: **more time is passing during orders than what is needed to execute them** and **the three steps linked to this are picking and packing, waiting for FTLs, and unloading.**

FIRST

We can observe the relationship between **actual vs value added time** colored by process step.

You can see it is picking and packing, waiting for FTLs, and unloading which are variable. (Select them in the color legend)



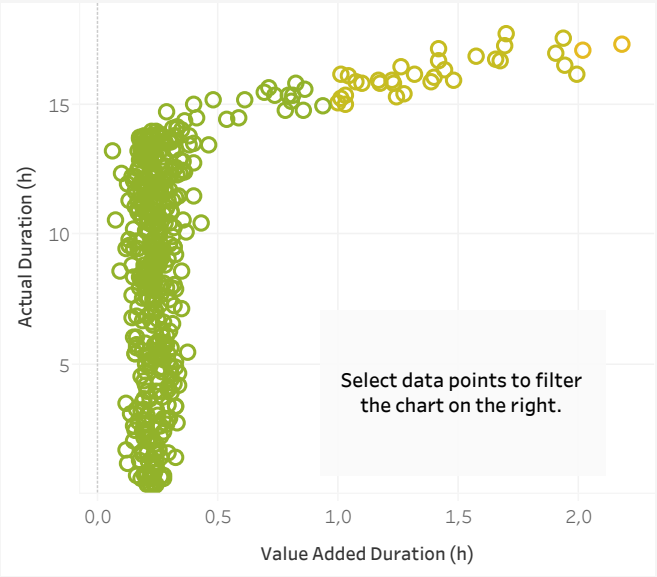
Color legend (Process step)

- Driving to customer
- Order picked and packed
- Order loaded
- Unloaded at customer
- Order received
- Waiting until full-truck volume

SECOND

Now that the directly related values are removed. We have colored these incidents by the time of day.

We can see that **every event** where the actual duration is different from value added duration **occurs shortly after business hours begin**.



Color legend (Hour of timestamp)

0	4	8	12	16	20
1	5	9	13	17	21
2	6	10	14	18	22
3	7	11	15	19	23

THIRD

If we then select some events on the graph to the left, we can filter the below table to see the timeline of those orders.

What we find by looking through the orders is that **there are three types of things leading to these long delays**:

1. an order is received outside of business hours so picking and packing needs to wait until the business is open.
2. there are not enough FTL volumes for a shipment so the waiting continues overnight.
3. a delivery arrives at the customer outside of business hours and needs to wait.

Order	Step	Timestamp
1	Order received	8/05/2016 11:00:00
	Order picked and packed	8/05/2016 11:16:33
	Waiting until full-truck volume	8/05/2016 11:59:38
	Order loaded	8/05/2016 12:19:18
	Driving to customer	8/05/2016 15:37:14
	Unloaded at customer	8/05/2016 15:51:29
2	Order received	13/05/2016 20:04:19
	Order picked and packed	14/05/2016 7:09:10
	Waiting until full-truck volume	14/05/2016 7:50:21
	Order loaded	14/05/2016 7:58:48
	Driving to customer	14/05/2016 10:56:37
	Unloaded at customer	14/05/2016 11:17:48
3	Order received	18/05/2016 12:22:38
	Order picked and packed	18/05/2016 12:35:01
	Waiting until full-truck volume	18/05/2016 13:15:46
	Order loaded	18/05/2016 13:29:14
	Driving to customer	18/05/2016 16:30:04
	Unloaded at customer	18/05/2016 16:43:45

Supply Chain Simulation

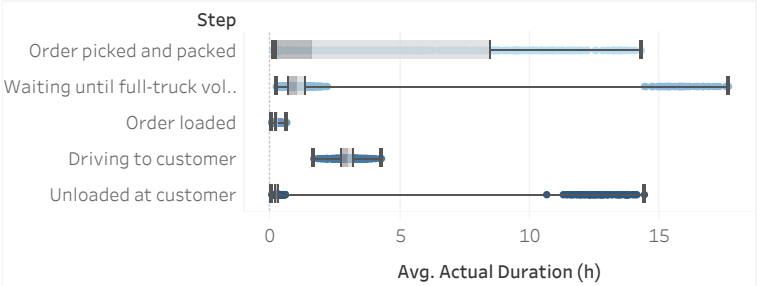
Next, let's take a look at variation in the supply chain.

FIRST

These charts show a breakdown of the different durations of each step in the supply chain.

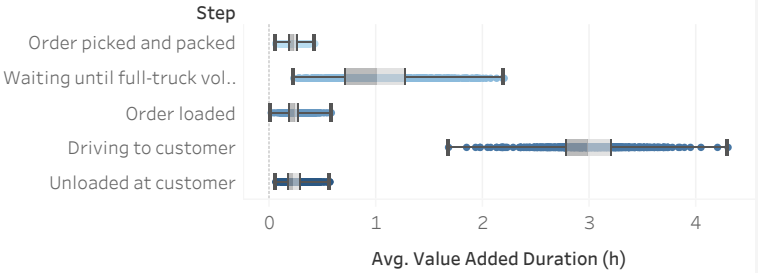
We see huge fluctuations when looking at actual time, but we have already determined the reasons for those in the previous slide.

Step Actual Duration Breakdown



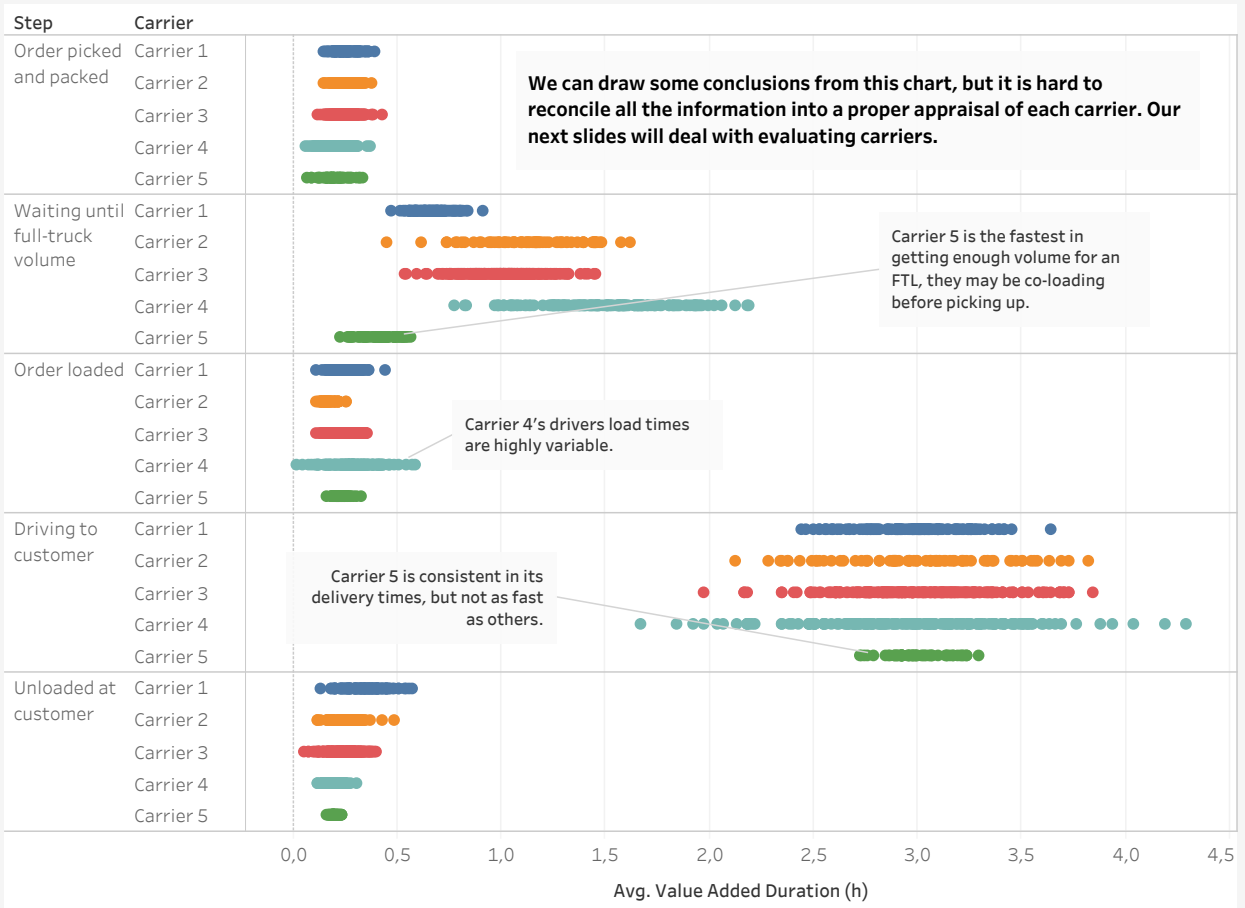
When we look at the **value added durations below**, we can see which steps in our supply chain process are variable. For the most part, **it looks like waiting for FTLs and driving to the customer are the big sources of variability**. Adding a carrier dimension may help us understand this variability.

Step Value Added Duration Breakdown



SECOND

Carrier Step Value Added Duration Breakdown



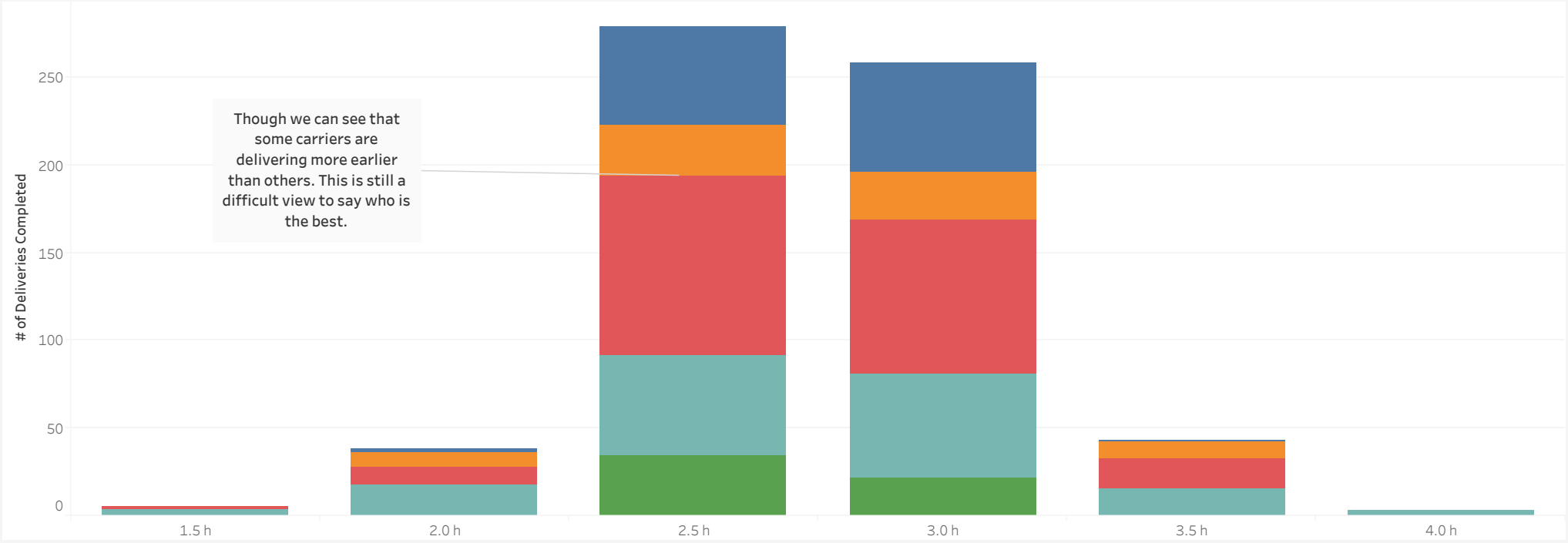
Carrier Network - A First Look

Our network has **four carriers** doing deliveries.

We want to see **who's doing what**, and **who's the best** at it.

Carrier 1	Carrier 2	Carrier 3	Carrier 4	Carrier 5
121 deliveries	73 deliveries	218 deliveries	158 deliveries	56 deliveries

For a first look at the data, we have split up the **deliveries each carrier made per day** below.

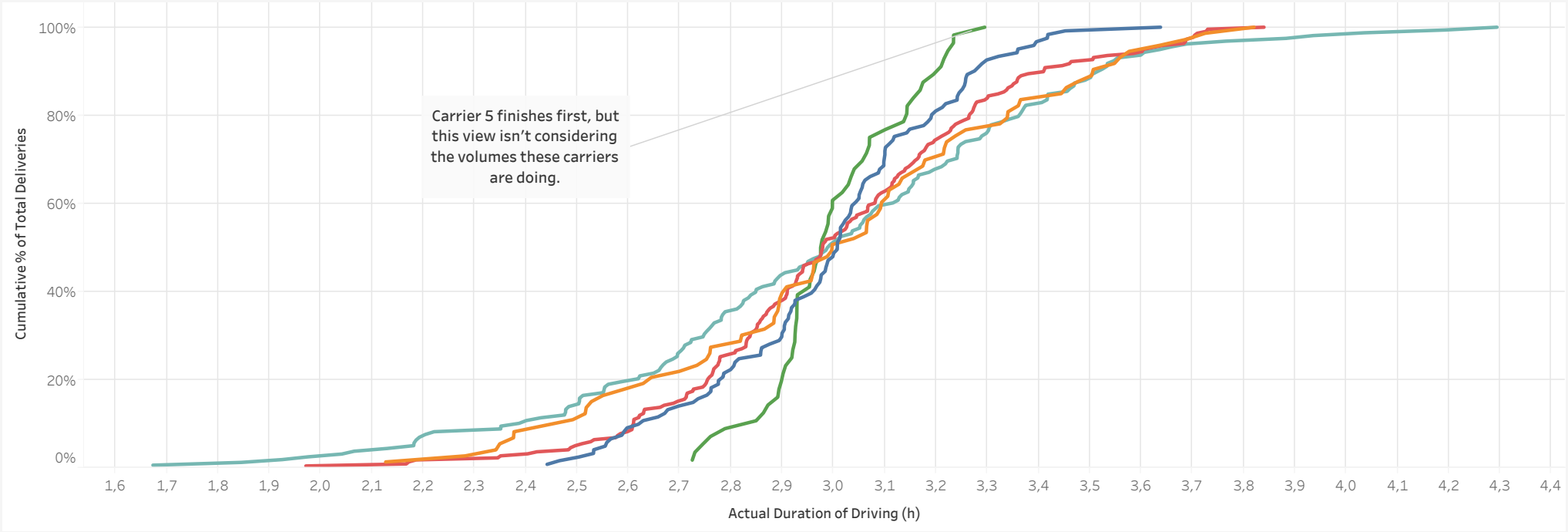


Carrier Network - Who is Fastest?

Time to Finish All Deliveries

Carrier 1	Carrier 2	Carrier 3	Carrier 4	Carrier 5
3,6378 hours	3,8202 hours	3,8396 hours	4,2940 hours	3,2950 hours

To put the carriers performances into comparative terms we decided to look at **how long it took to complete all deliveries per carrier**.



Carrier Network - Carrier Efficiency KPI

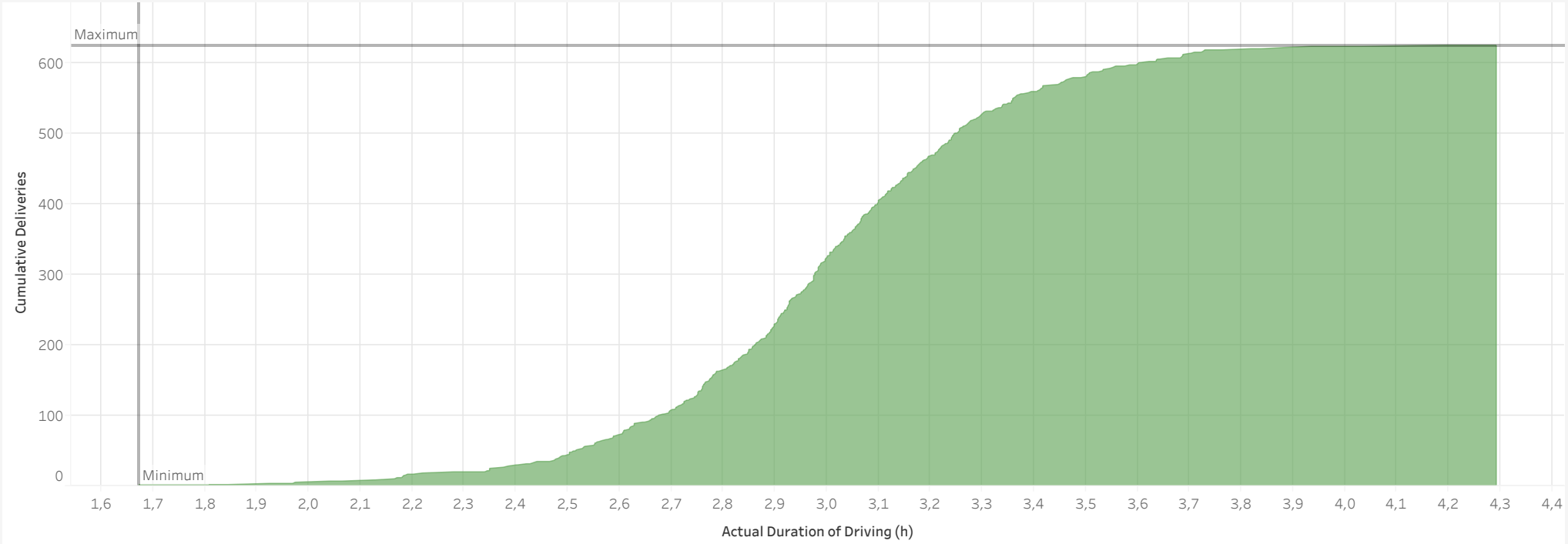
To consider **time until completion** AND **number of deliveries**, we created a new KPI called **Carrier Efficiency**.

Carrier Efficiency = Area Below the Curve **/** Total area of the Chart

The **perfect value (1)** with this KPI means the carrier **delivered everything immediately**.
The **worst value (0)** means the carrier **delivered everything at the last second**.

KPI Total

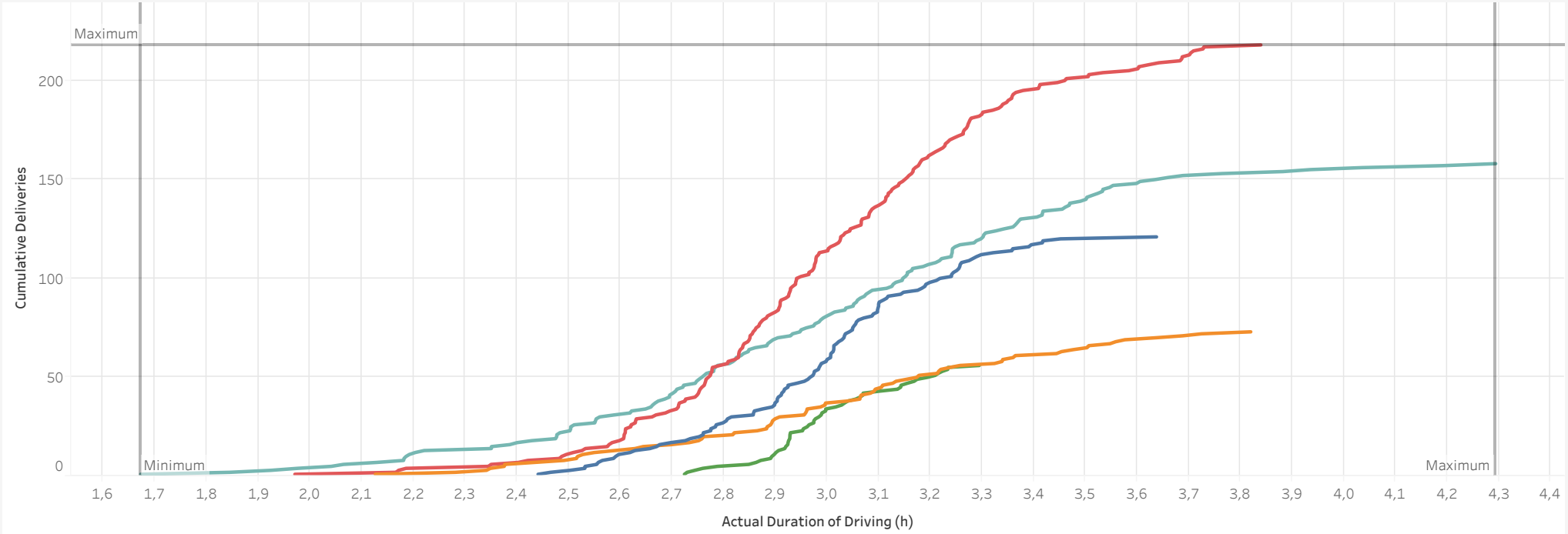
49,83%



Carrier Network - Evaluating Performance

Carrier 1	Carrier 2	Carrier 3	Carrier 4	Carrier 5
50,05%	49,63%	49,41%	50,69%	49,64%

By implementing this KPI, we now have a **comparable value for evaluating the different carriers** even if they are serving different volumes. Carrier 4 scores the highest.



Ahlers Warehousing - St. Petersburg

This analysis is based on timestamp and order data provided by our warehouse in St. Petersburg. Below are some aggregate figures about the orders and the stages of the process. Hover over the icons to learn more.

Warehousing Process Stages

Order receipt | Order started picking | Order ended picking | Order checked and ready for shipment | Truck entered on territory | Order started loading | Order ended loading | Truck left the territory | Delivery date

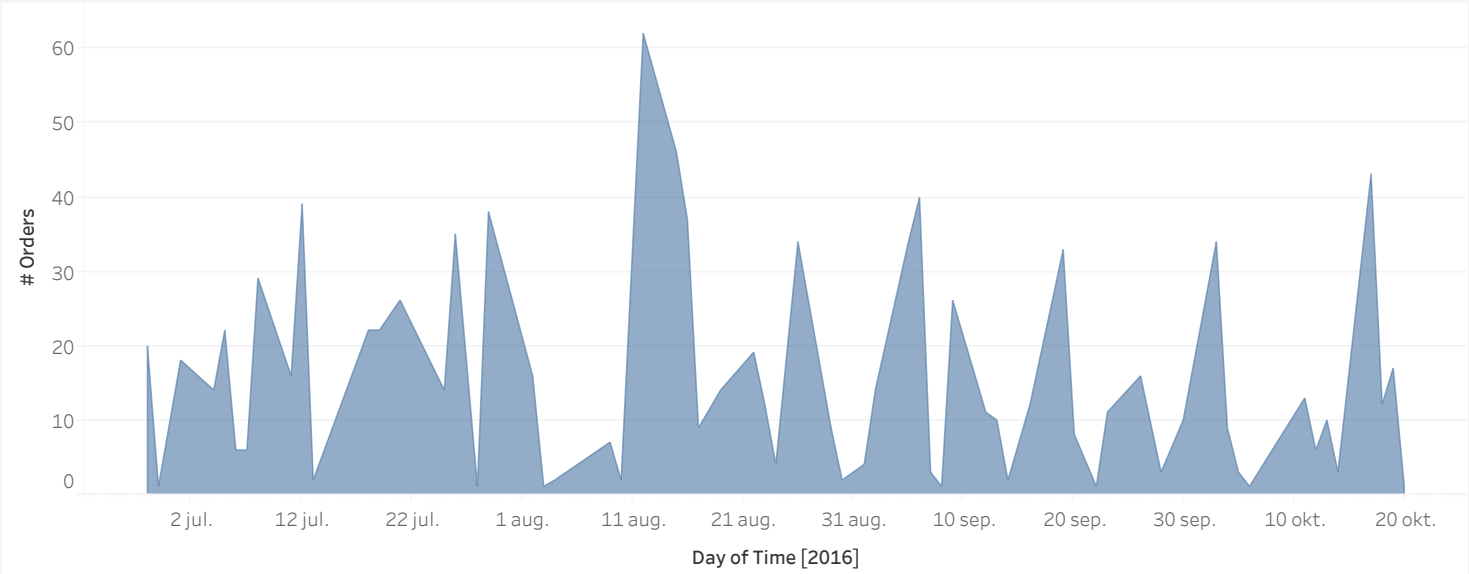
Total Orders
999

Total Hours
68.397

Average Order Duration
68,47

Standard Deviation
31,01

Orders Over Time

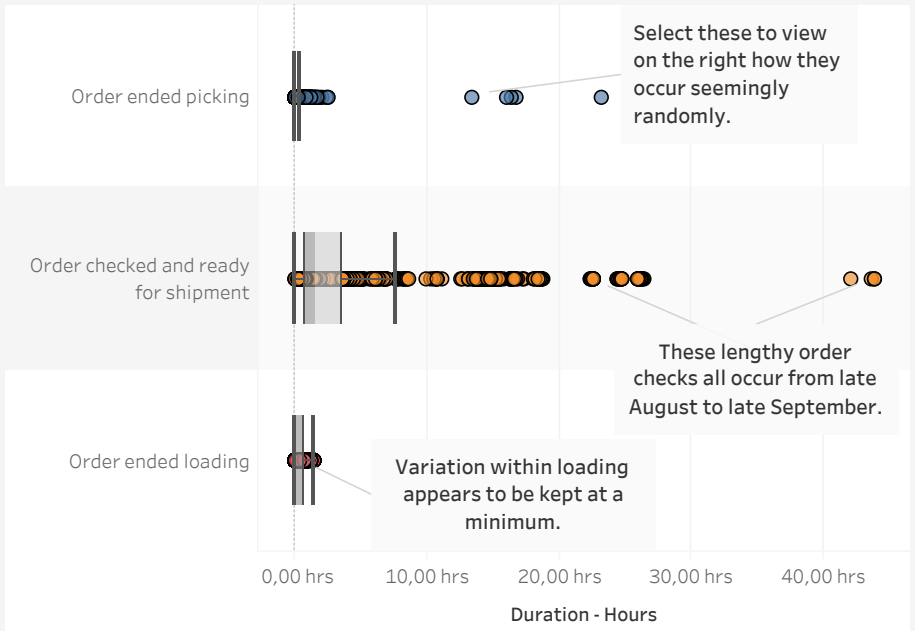


Ahlers Warehousing - St. Petersburg

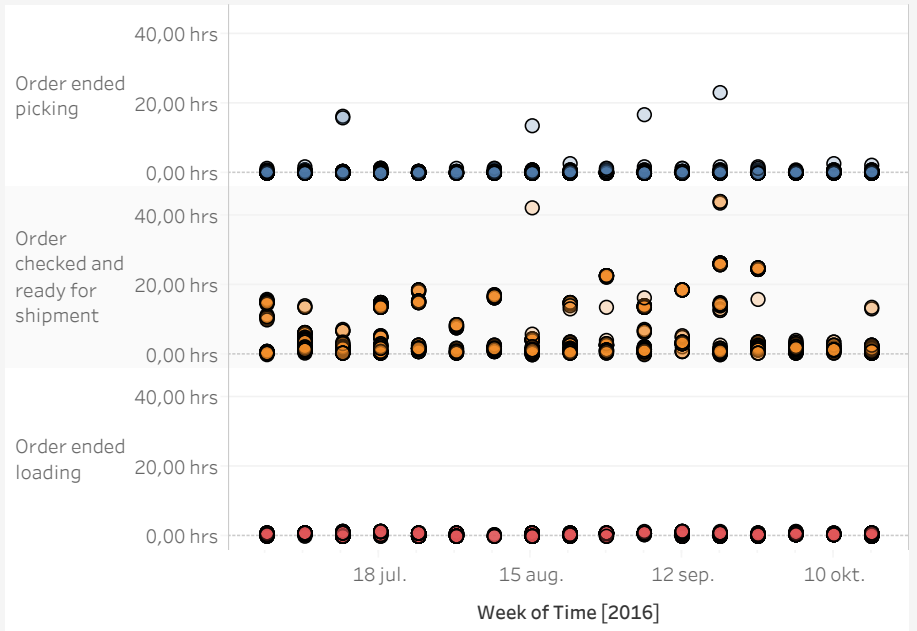
The first three steps we will look at are picking, order checking, and loading. This is because they are arguably clearly defined durations which show the efficacy of employees.

Order ended picking		Order checked and ready for shipment		Order ended loading	
Average Duration	Standard Deviation	Average Duration	Standard Deviation	Average Duration	Standard Deviation
0,20 hrs	1,25 hrs	4,40 hrs	6,59 hrs	0,47 hrs	0,33 hrs

Duration Distribution



Duration Distribution Over Time



Ahlers Warehousing - St. Petersburg

Another interesting thing to look at is when trucks are arriving to pick up shipments and how this impacts the total order duration.

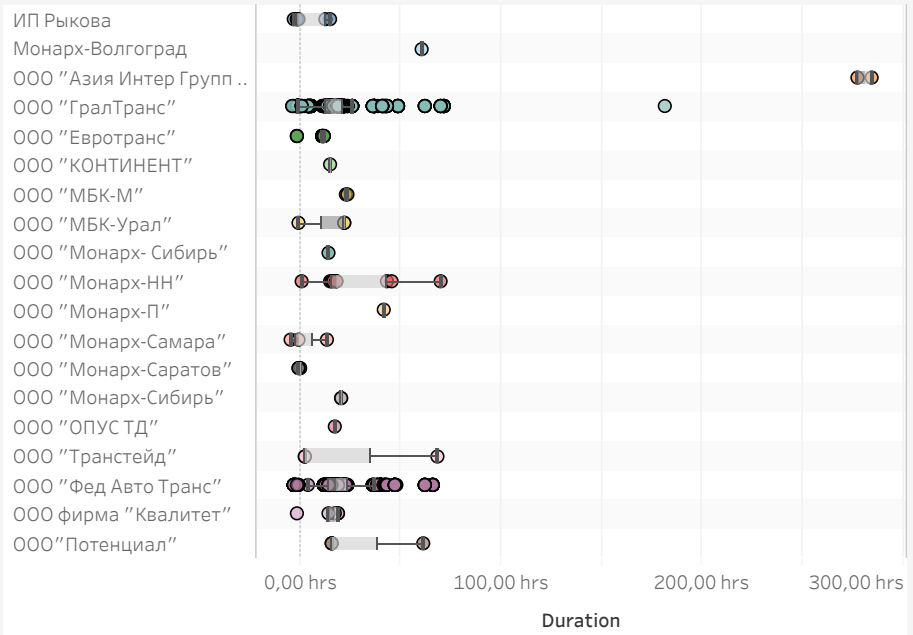
Truck entered on territory

Average Duration	Standard Deviation
21,12 hrs	20,23 hrs

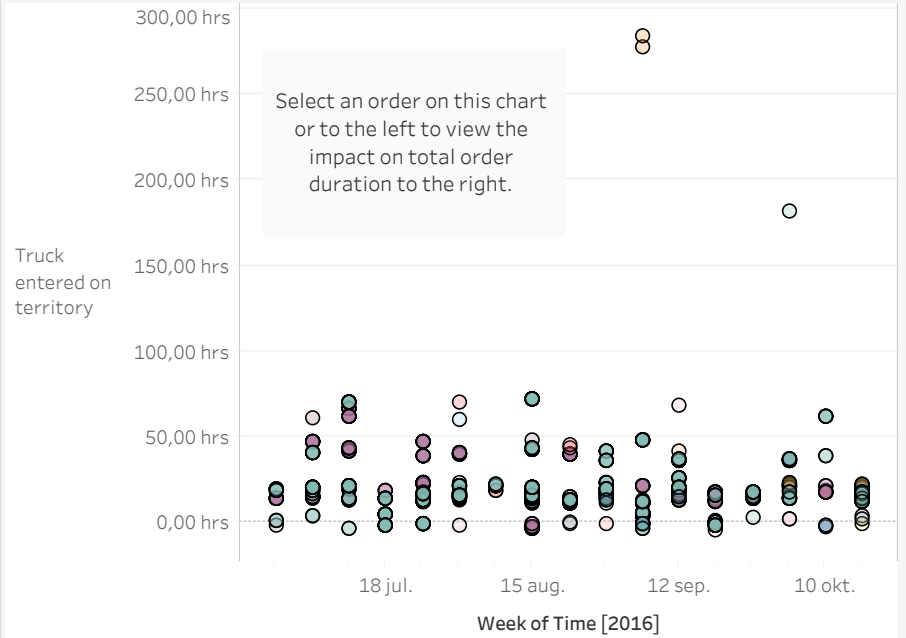
ООО "ГралТранс"
505 orders arrived after order ready

ООО "Фед Авто Транс"
350 orders arrived after order ready

Duration Distribution

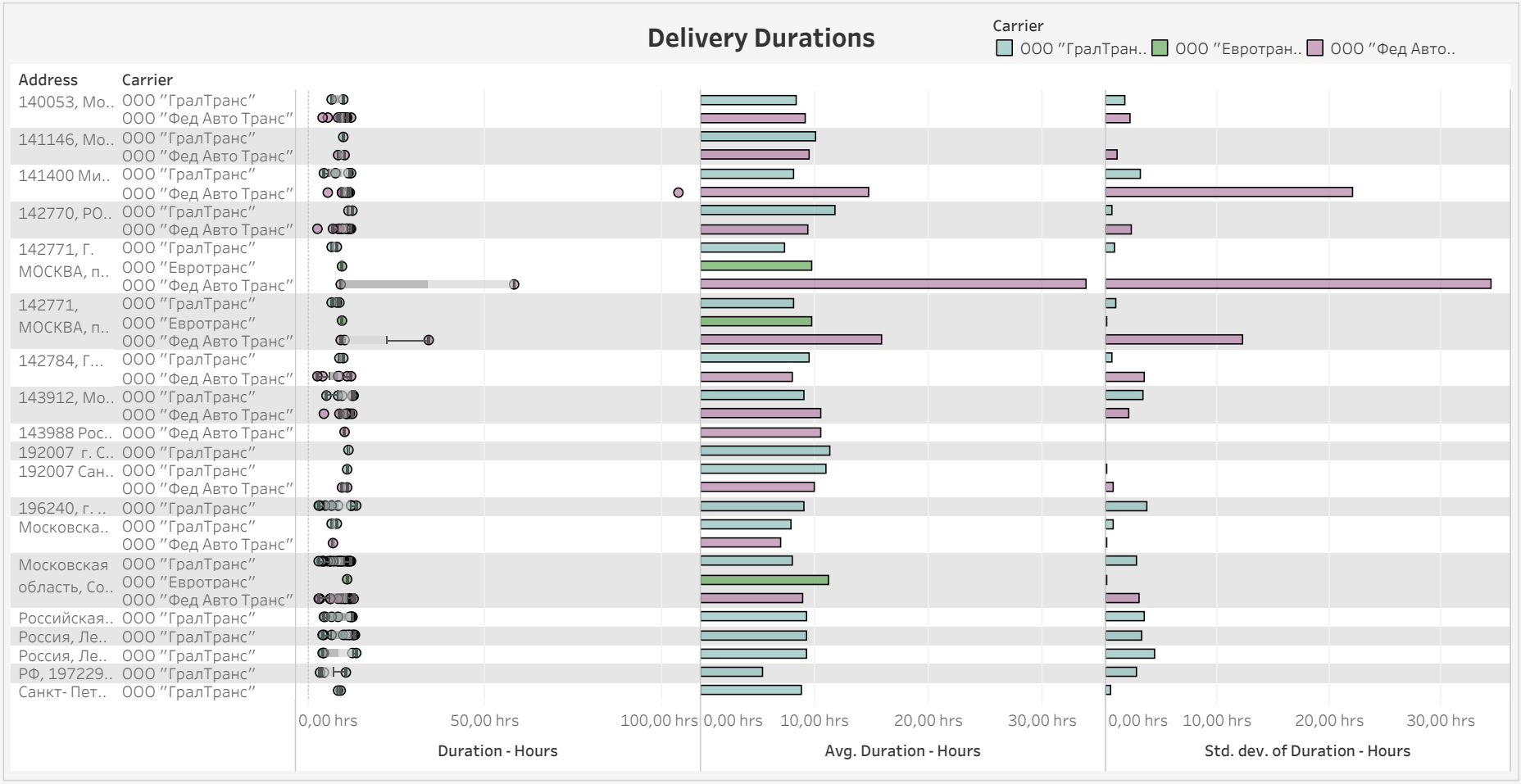


Duration Distribution Over Time



Ahlers Warehousing - St. Petersburg

Here we can see how carriers perform across routes individually, on average, and in terms of variability.



Ahlers Warehousing - St. Petersburg

We applied our Carrier KPI to routes which had viable data and now the carriers' performances are comparable.

Overall Performance:

ООО "ГралТранс"	ООО "Фед Авто ..
67,32%	66,53%

Carrier Efficiency Scores

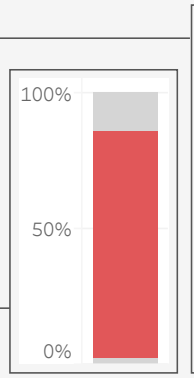
Delivery Point	Carrier	
140053, Московская область, Котельники г,,1-ый Покровский проезд,1	ООО "ГралТранс"	57,68%
	ООО "Фед Авто Транс"	40,99%
141146, Москов.обл., Щелковский р-н.,п. Фряново	ООО "Фед Авто Транс"	75,00%
141400 Микрарайон ИКЕА, корпус 3, Московская обл., г. Химки	ООО "ГралТранс"	97,32%
	ООО "Фед Авто Транс"	92,78%
142770, РОССИЯ, Г. МОСКВА, П. СОСЕНСКОЕ, Калужское шоссе 21 км, Торгово-развлекательный центр	ООО "ГралТранс"	91,47%
	ООО "Фед Авто Транс"	87,22%
142771, Г. МОСКВА, пос. Мосрентген, склад	ООО "ГралТранс"	99,42%
	ООО "Фед Авто Транс"	71,19%
142771, МОСКВА, пос.Мосрентген, склад	ООО "ГралТранс"	96,61%
	ООО "Фед Авто Транс"	78,40%
142784, Г.МОСКВА, ПОСЕЛЕНИЕ МОСКОВСКИЙ, г.Московский, вблизи д. Говорово, 47км МКАД	ООО "ГралТранс"	32,13%
	ООО "Фед Авто Транс"	53,12%
143912, Московская обл., г. Балашиха, Западная промзона, Шоссе Энтузиастов, д. 4	ООО "ГралТранс"	53,99%
	ООО "Фед Авто Транс"	33,98%
192007 Санкт-Петербург, пр. Качалова 21	ООО "Фед Авто Транс"	90,00%
196240, г. Санкт-Петербург, Пулковское шоссе, д. 21, корп. 1.	ООО "ГралТранс"	50,25%
Московская обл, пос. Мамыри, Калужское шоссе, 1-ый км	ООО "ГралТранс"	62,50%
Московская область, Солнечногорский район, сельское поселение Пешковское, д. Шелепаново, строение 152/1	ООО "ГралТранс"	50,54%
	ООО "Фед Авто Транс"	42,63%
Российская Федерация, г. Санкт-Петербург,196244, Космонавтов пр-кт,14	ООО "ГралТранс"	47,53%
Россия, Ленинградская обл., Всеволожский р-н, Мурманское шоссе, 12 км	ООО "ГралТранс"	48,67%
Россия, Ленинградская обл., Всеволожский р-н, пересечение проспекта Энгельса и КАД	ООО "ГралТранс"	61,39%
РФ, 197229, г. Санкт-Петербург, поселок Лахта, Проспект Лахтинский, 85	ООО "ГралТранс"	85,37%
Санкт- Петербург, пр. Качалова, д.21	ООО "ГралТранс"	75,00%

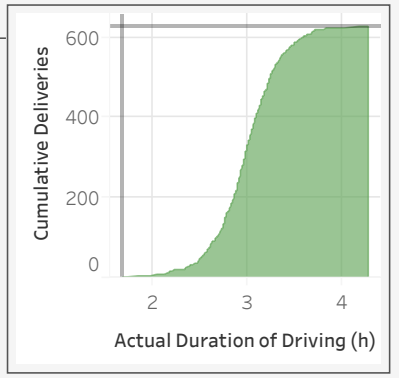
Conclusions

Throughout this presentation we were able to provide many different types of ways to evaluate time within a supply chain and analyse process performance.

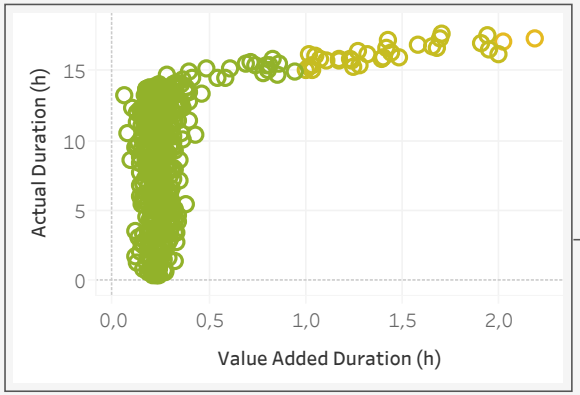
Practical applications with real-world data

Carrier efficiency KPI that considers volume and time



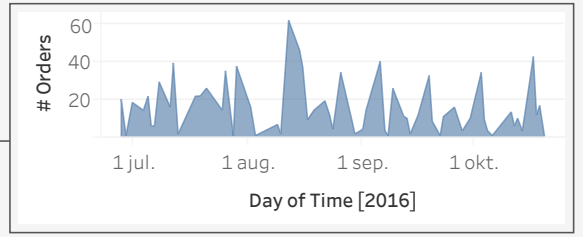


Step influence on full processes



Relationships between actual and value added time

Seasonality and variability of volumes



Comparative analysis of carrier performance and volumes

Insights on variability and time performance of carriers