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A Simple Guide for Transit Time Analysis

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Overview of Transit Time

The purpose of this project is to explore interesting statistics about transit time as well as the key variables that impact transit time. The insights are generated based on analysis of a sample of truckload shipments. Transit time is a very prominent topic in Transportation Logistics. Transit time is defined as the gap (in days or hours) between the pickup and delivery of a shipment.

There are different parameters that influence the variance in transit time. Intuitively, as the transit time increases, the amount of uncertainty also increases. This is not always a function of the distance as air shipments across continents have a longer distance, but shorter transit time compared to domestic shipments. Apart from distance, the nature of the shipping location (or product) and the number of stops in a shipment influence the shipment transit time.

In general, a standard transit time expectation can be defined at varying levels of granularity. If a shipment is on-time is determined by comparing the actual transit time versus the standard transit time. Logistics practitioners know that customers appreciate consistency in transit times and with similar level of interest, expect reliability in expected delivery times.

Data Science and specifically Machine Learning (ML) can be quite useful in predicting transit time and on-time performance. Using a ML model, it is possible to predict the ETA as well as if a shipment will be delivered on-time or late. The most famous and widely used transit time predictor is Google Maps. Similar use cases in action can be seen at Instacart & Uber.

Part I: How long does it take to deliver the shipments?

Transit time can be defined as the duration between pickup and delivery of a shipment. In simpler terms, transit time is the length of time to deliver a shipment. The average transit time for a shipment is 5.48 days. As shown in figure 1, median transit time is 5 days. 50% of the shipments are being delivered between 3 and 7 days [25^{th} and 75^{th} percentile respectively].

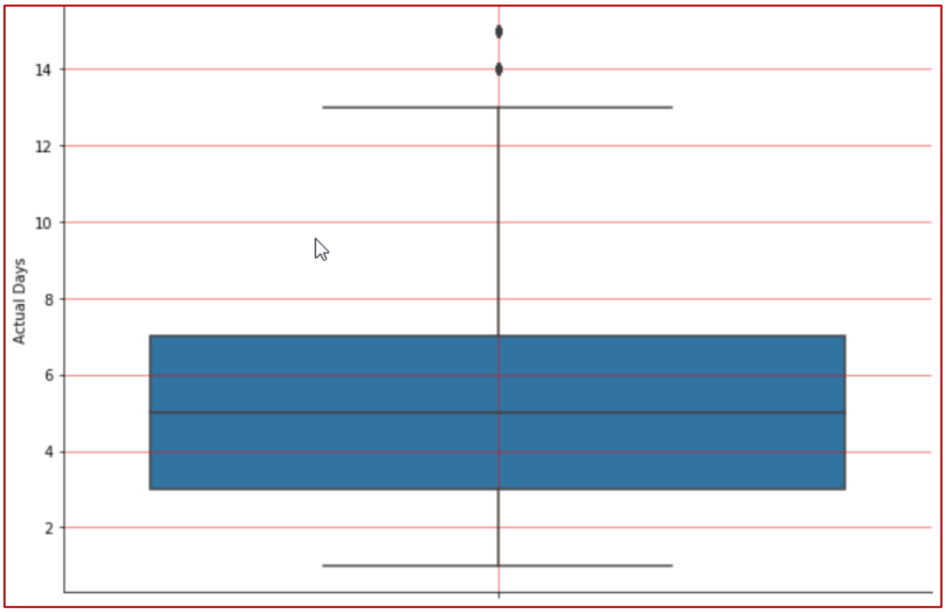

Figure 1: Box plot of Transit Time showing min, percentiles (25^{th}, 50^{th}, 75^{th}) and max values

As shown in figure 2, 90% of the shipments are delivered within 10 days. Further, the long tail of transit time values starts at 8 days.

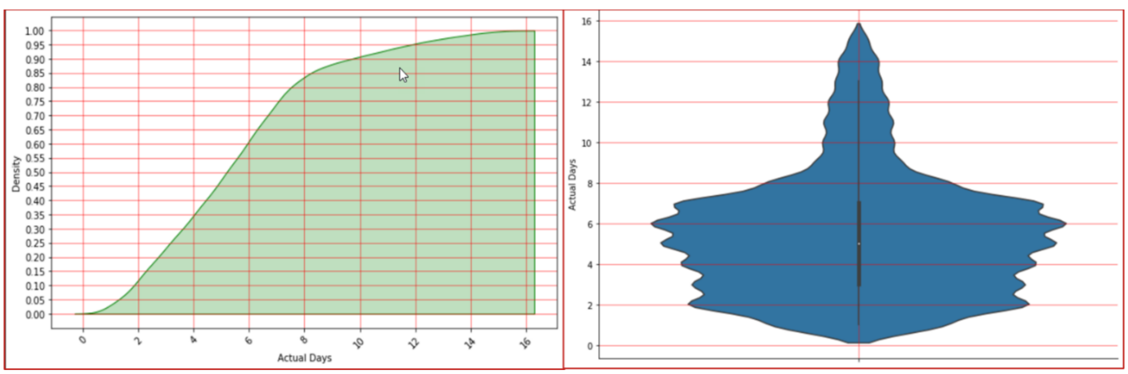

Figure 2: Distribution of transit time (density and violin plot)

From a business perspective, shipments over 8 days can be viewed as exceptional. In general, operational processes should monitor any in-transit shipment that is delayed versus the standard transit time. In addition, an additional critical datapoint for daily monitoring would be any shipments that are in-transit 8 or more days after pickup.

Part II: When are the shipments tendered?

Shipments are tendered to the transportation carriers. Upon receiving the tender, carrier has the option of accepting or declining the tender. If a carrier accepts the tender, they are also agreeing to the general requirements for picking up and delivering the shipment. Across all location types, 6.3% more shipments are tendered on Mondays compared to other days of the week.

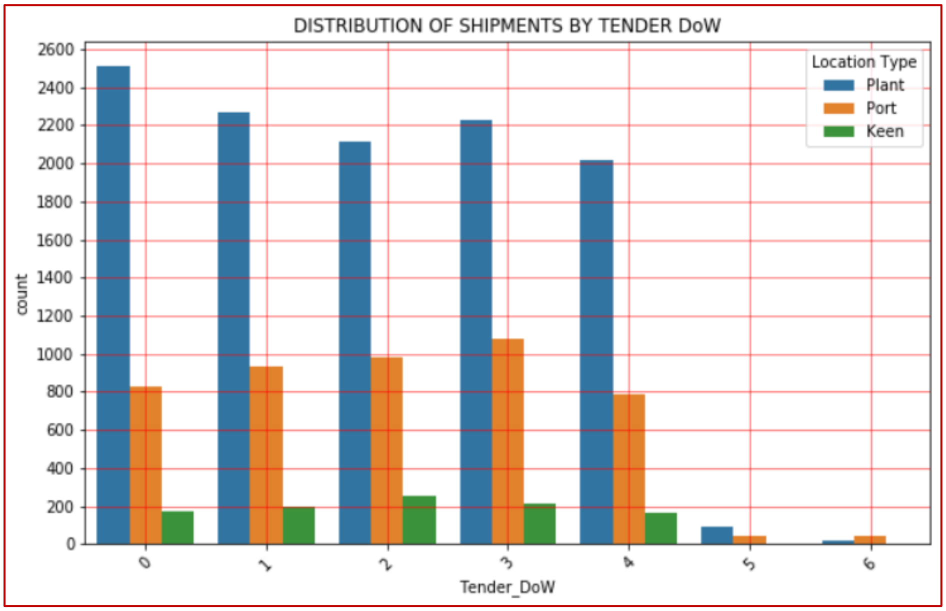

Figure 3: Count of shipments tendered by day of week, 1 = Monday

Index	Location Type	Mon_Shipment_Count	Non_Mon_Shipment_Count	Avg_By_Day
0	Plant	2513	2155	2227
1	Port	827	943	920
2	Keen	173	205	198
3	Total	3513	3303	3345

Figure 4: Count of shipments tendered by day (Mon = Monday)

As shown in figures 3 & 4, this effect is more pronounced for shipments originating from the plants. For plants, 14.2% more shipments are tendered on Mondays compared to other days of the week. For non-plant locations (ports, Keen), linear tender volumes are observed across the days of the week. Knowledge of the tender distribution volume can be shared with the carriers and thereby, enable them to plan for capacity.

Part III: How far do the shipments travel?

For truckload shipments, distance is one of the main parameters for determining the transit time. It is important to note that certain specialized truckloads are permitted to travel only during daylight hours and depending on the freight dimensions, may have to follow special routing.

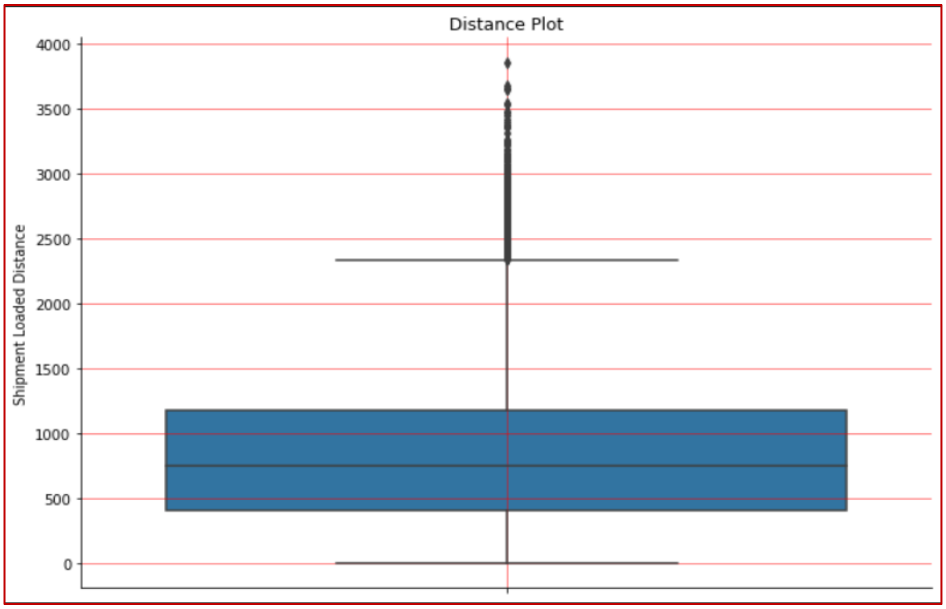

Figure 5: Distribution of shipment distance

The average distance travelled by a shipment is 842 miles. As shown in figure 5, median shipment distance is 748 miles. 50% of the shipments travel a distance between 748 and 1180 miles [25th and 75th percentile respectively]. As shown in figure 6, 90% of the shipments travel 1600 miles or less. Further, the long tail of distance values starts at around 1800 miles.

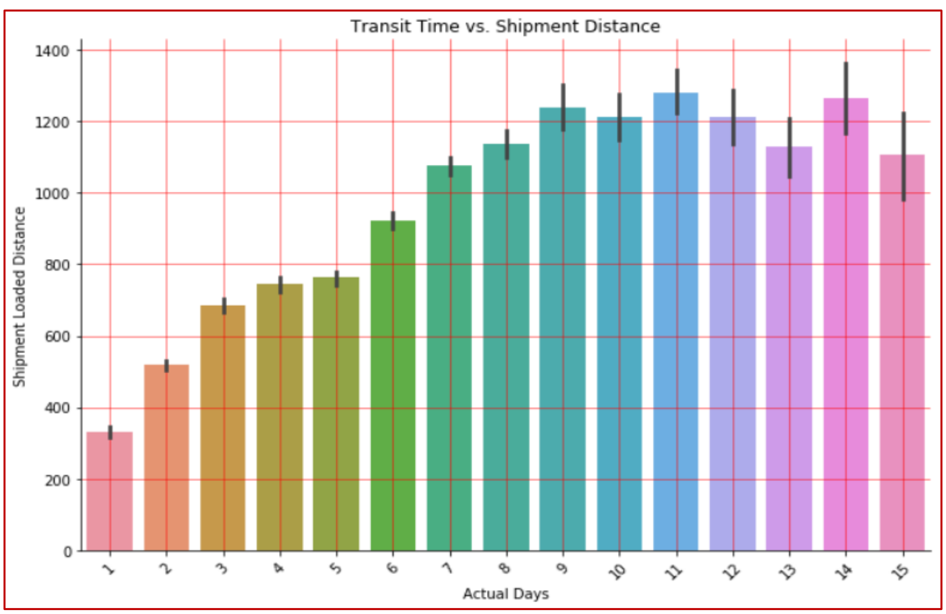

Figure 6: Transit time vs. shipment distance

As shown in figure 6, transit time increases with shipment distance up to a transit time of 9 days. There are specific rules that govern the calculation of transit time and take into consideration numerous parameters such as distance, truck speed, permitted driving hours etc. Due to the complexity, the definition of transit time rules is more art than science. From a business perspective, the transit time rules should focus on driving alignment between the rules and reality for shipments travelling up to 1600 miles (90th percentile).

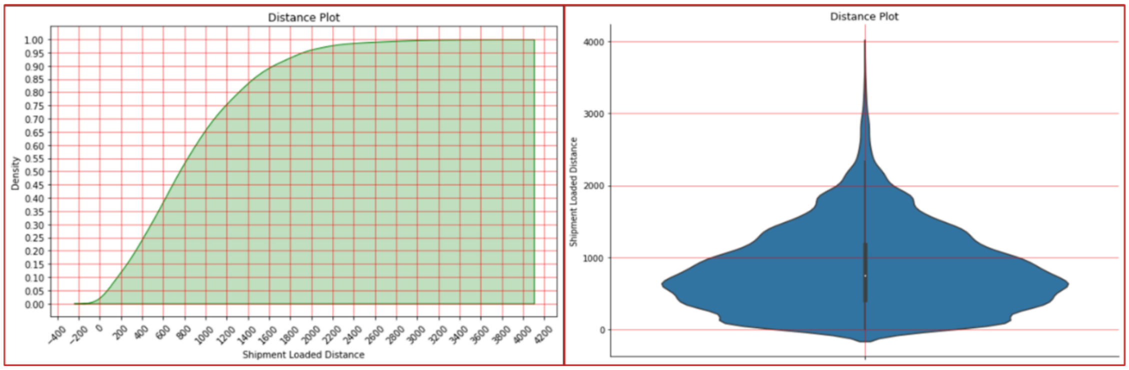

Figure 7: Distribution of shipment loaded distance

Further as shown in figure 7, plant shipments travel farther (average: 30% greater and median: 37% greater) compared to shipments originating from other location types. Accordingly, the transit time for plant shipments can be expected to be longer than shipments originating from other locations.

Index	Location Type	Avg_Distance	Median_Distance	Shipment_Count
0	Plant	888	829	11152
1	Port	700	633	4612
2	Keen	615	476	977
3	Port & Keen	685	606	5589
4	All	820	742	16741

Figure 8: Summary of shipment loaded distance by location type

Part IV: How many stops do the shipments make till final delivery?

Truckload shipments start at the origin from where the freight is picked up. After the pickup, the shipment might head directly to the destination. On the other hand, it is also possible that the shipment might stop at intermediate locations. Freight can be picked up or dropped off at these intermediate locations. The shipments analyzed in this project, could have intermediate stops and the only function of the intermediate stops is to receive freight (not ship freight). The total stops per shipment consists of pickup location, delivery location and any intermediate stops. Therefore, all shipments will have a minimum of 2 stops.

Figure 9: Shipment stops

The average stops per shipment is 2.8. As shown in figure 9, median stops per shipment is 2. 50% of the shipments have between 2 and 3 stops [25^{th} and 75^{th} percentile respectively]. As shown in figure 10, 95% of the shipments have 5 stops or less. Further, the long tail of stops per shipment starts at 5.

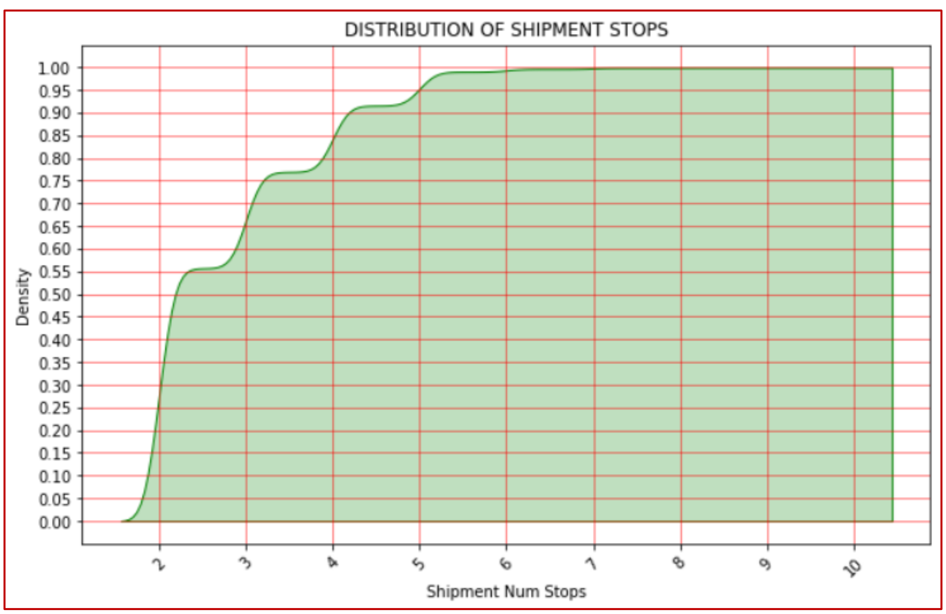

Figure 10: Volume density distribution of shipment stops

Stops per shipment impact the total distance of the shipment by introducing out-of-route miles to the shortest distance between origin and destination. In general, it is reasonable to expect the shipment distance to increase with the number of stops. This is shown in figure 11.

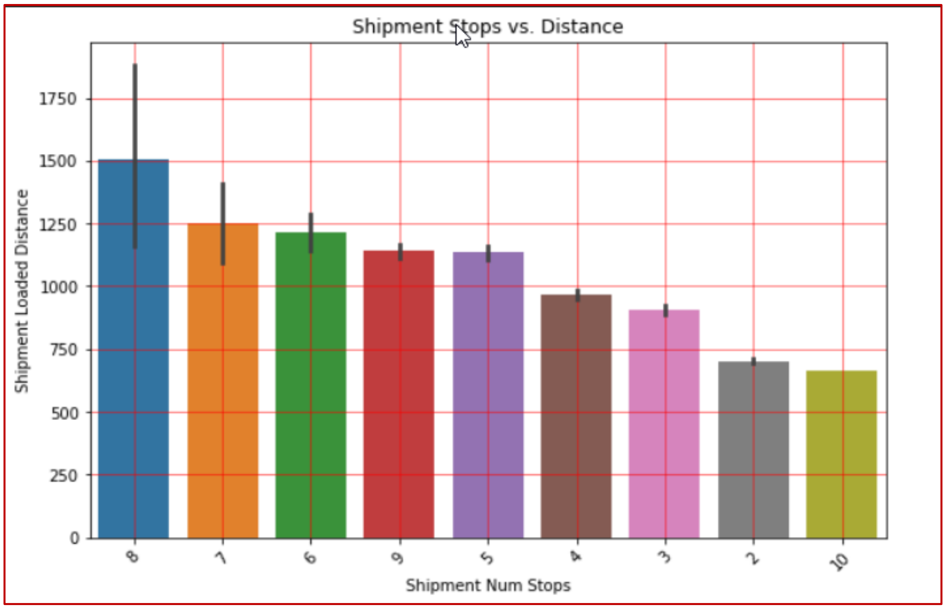

Figure 11: Shipment stops vs. distance

The cost of additional distance can be offset by increased truck utilization and potential elimination of an additional shipment. The additional distance will add to the transit time of the shipment. In addition, the time necessary to service the stop will also add to the transit time.

Conclusion

Transit time is a very important metric in transportation. The transit time expected by the customer dictates the choice of transportation mode and therefore the cost. For truckload transportation, factors such as distance and number of stops influence the transit time. As illustrated in this study, transit time increases with distance and number of stops. In addition, volume of shipments tendered by day (of week) is a datapoint that can be used to establish daily capacity expectations with service providers. A possible extension of the study would be the development of standard transit time rules based on parameters analyzed in this study.