Root cause analysis and impact of unplanned procurement on truckload transportation costs

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Summary: The tender rejection rate by primary carriers for the TMC division of CH Robinson nearly doubled from 2015-16 to 2017-18. An increase in tender rejection rates directly results in an increase in transportation costs for shippers. Increasing demand in the market from 2015 to 2018 was a major cause of the increase in tender rejections. There was no evidence that increasing tender lead times decrease tender rejections. However, the research found that improving lane consistency and controlling volatility can lower costs and reduce tender rejection rates. While key market areas which are expensive as origins are cheaper as a destination and vice-versa, no such pattern was observed for tender rejection rates.

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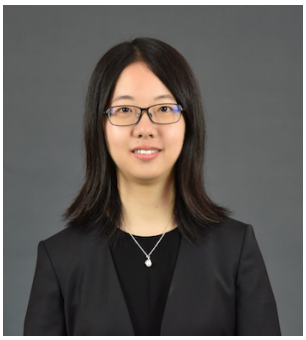

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KEY INSIGHTS

1. **Shorter tender lead times were associated with higher costs but lower tender rejection rates.**
2. **Improving lane consistency and controlling volatility can lower costs and reduce tender rejection rates for shippers**
3. **Key market areas which are expensive as origins are cheaper as a destination and vice-versa. No such pattern was observed for tender rejection rates.**

Introduction

In the United States, business logistics costs constitute 7.7% of the total GDP. The US truckload transportation industry had $641 billion in revenue in 2017, which accounted for approximately 66.4% of the total logistics spend in the country. Full truckload (TL) transportation accounted for $289 billion in revenue, less than truckload accounted for $62 billion, and the rest was accounted for by private or dedicated fleets. In 2017- 2018, the US trucking market became incredibly tight as demand outstripped supply. This led to a sharp rise in rates and a dip in service levels.

Truckload procurement process

Shippers procure the services of carriers through a procurement process that consists of five steps

1. Carrier Screening - Shippers use a screening mechanism to reduce the number of potential carriers. The criteria used for screening include the geographic area covered, financial position, availability of equipment, etc. This step ensures the candidates meet the minimum qualifying criteria.
2. Information exchange - The carriers selected in the screening process are then given specific details related to the shippers' network requirements. This information may or may not be standardized.
3. Carrier assignment – Based on submitted bid prices by carriers, the shipper uses the Winner Determination Problem (WDP) which is a Mixed Integer Programming (MIP) model, to assign lanes to carriers. Carriers are allowed to submit package bids for a group of lanes. The results of the WDP are uploaded to form the routing guides, an electronic catalog used by shippers. Carriers are assigned ranks in the routing guide sequence, which is typically determined based on the bid prices, performance levels, carrier capacities, and other selection logic. Carriers that rank first in the routing guide are called the primary carriers and are given the highest priority when tendering a shipment. There may be more than one primary carrier for a particular lane. Primary carriers are

expected to accept loads when they get the tenders

4. Load tendering - This is the real-time process of assigning shipments to various carriers based on the routing guide. Since contracts are non-binding on both the carrier and shipper, the latter may have to go through a number of alternative carriers before a load gets assigned. If no match is found through the routing guide, the shipper then goes to the spot market. The tender escalation process can be seen in Figure 1.
5. Performance review - In this step, the shipper tracks the carriers' performance using metrics such as refusal rates, on-time rates etc. Based on periodic performance review, routing guides are revised to allocate demand in an efficient manner to various carriers based on their capacity and service levels.

Economies of scale do not typically apply to the TL industry, where allocating more volume to a specific carrier does not always result in lower prices. The TL carrier's cost structure is more sensitive to economies of scope, where the cost of serving a lane depends on having an acceptable follow-on load. The truck usually needs to move empty to a different location (referred to as deadhead miles) and the driver will have to wait before a subsequent load is picked up. The carrier's overall costs increase with an increase in deadhead miles. Distance accounts for 70-80% of the variability in transportation rates paid by shippers and rest are determined by factors such as regional sensitivity, dwell times and freight imbalances.

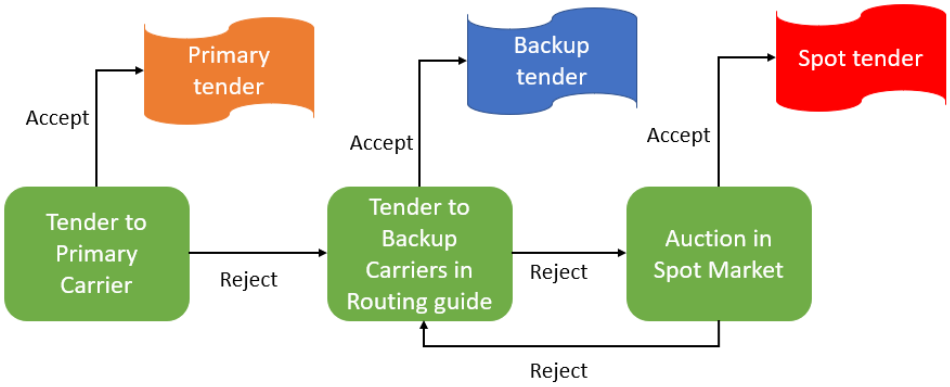

Figure 1. Tender Escalation Process

Available tender lead time affects the carrier's probability of securing an acceptable follow-on load, the uncertainty of which further builds into the costs of the carrier. Similarly, if a carrier is offered shipments on a consistent basis, the uncertainty and therefore has an impact on costs.

The objective of this project was to identify the causes for an increase in tender rejection rates and costs. We identified factors such as lane consistency, lane volatility, corridor volume, pickup day of the week, origin-destination characteristics, and tender lead times and estimated their impact on costs and tender rejections. We used three years of shippers' tender data from October 2015 to September 2018, which enabled us to capture the differences between soft market and tight market conditions.

Methodology

Our methodology for conducting this research is divided into three steps: data preparation, data characterization and data modeling.

Only full-truckload dry van shipments with >250 miles in length of the haul (or long-haul shipments) were considered for this study. Short-haul shipments behave differently from long-haul and have been excluded. Only dry van shipments have been included because other shipment types form a smaller percentage of the overall dataset and are less standardized. For data preparation stage, all the transactions with missing pickup date, tender date or linehaul rate information are removed as they are essential to tender lead times and costs respectively. Transactions with erroneous cost per mile (CPM) data were also removed. Data characterization was conducted using Tableau to observe correlations among different variables and establish hypotheses for data modeling. An OLS multiple linear regression model was built to explain variance in Cost per load (CPL) and a logistic regression model was built to predict the tender acceptance rate by primary carrier and routing guide failure.

Preliminary findings

Figure 2 shows the average increase in CPM with increasing routing guide depth. The percentage premium was determined for each sequence number (increase in average CPM for that sequence number compared to the CPM of primary carrier) lane wise. As going deeper into the routing guide, the percentage increase in CPM keeps increasing at a decreasing rate and tapers off after sequence number 5. This suggests that moving from primary to second carrier is more costly than moving from second to third carrier. The percentage premium increased from the

soft period in 2015-16 to tight period in 2017-18. Moving from primary to 1st alternate has increased from 4.4% to 5.3% over the last 3 years. Figure 3 demonstrates the importance of preventing primary carrier rejection.

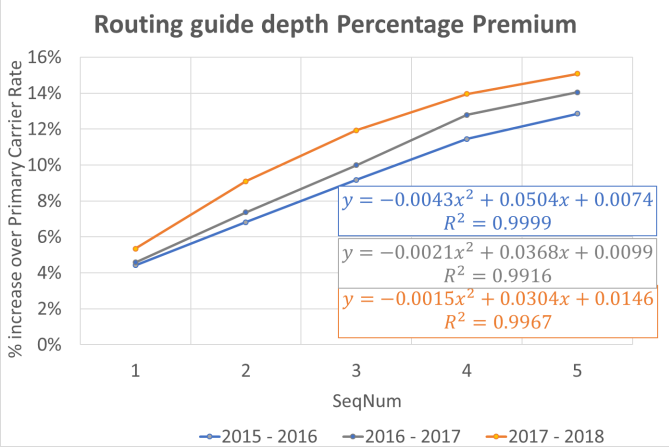

Figure 2. Percentage premium paid with increasing routing guide depth

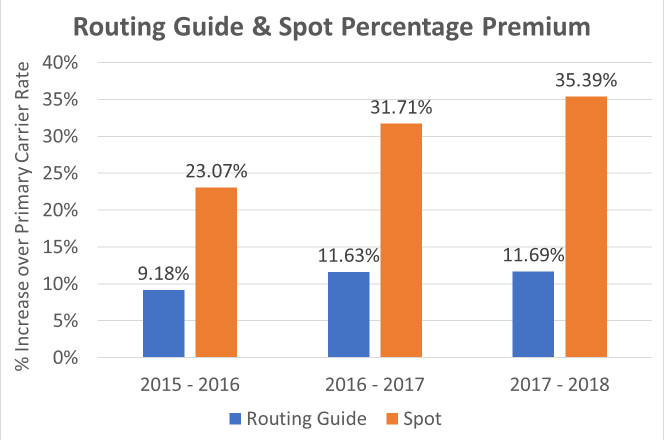

Figure 3. Percentage premium paid for backup and spot carriers

Data Modeling

OLS multiple linear regression was used to model the relationship between cost per load (CPL) and various attributes namely distance, lead time, corridor volume, lane consistency, lane volatility, weekend flag, the quarter end flag and key market areas and binary logistic regression was used to build two models - one to predict the probability of tender acceptance by primary carrier and another to predict the probability of routing guide failure based on different attributes of shipments. The variables used in these models are explained in detail in Table 1.

Table 1 Variables used in Regression Models

Variable	**Details**
Year	2015-16 - Oct 2015-Sept 2016 2016-17 - Oct 2016-Sept 2017 2017-18 - Oct 2017-Sept 2018
Distance	Continuous variable > 250 miles
Lead time	Time between tendered date and pickup date for each tender Three categories – Less than 2 days, 2-5 days (base) and more than 5 days
Corridor Volume	Corridor – volume between each 3-digit to 3-digit zip code region Low volume: < 5 loads per month Med volume: 5 - 30 loads per month High volume: > 30 loads per month
Lane Consistency	Lane - Route between each 5-digit to 5-digit zip code location Low: < 27 weeks annually Medium: 28 - 49 weeks annually High: > 49 weeks annually
Lane Volatility	Volatility is defined as Coefficient of Variation (CV) for a lane, calculated as the ratio of the standard deviation of weekly volume to mean weekly volume in a year for every lane (only the weeks with at least one load are considered)
Quarter-end Flag	Pickup in last 5 days in each quarter marked as Quarter-end
Weekend Flag	Monday-Thursday – Weekday Friday-Sunday – Weekend
Inbound/ Outbound	"Inbound" if number of origins >is greater than number of destinations for a shipper and "Outbound" otherwise
Key market areas	135 distinct areas that act as origins as well as destinations

The average CPL is lowest when the load gets accepted by a primary carrier. The average CPL increases when load goes to backup carriers in the routing guide and is highest when the load gets accepted in the spot market. Therefore, shippers should take steps to increase the primary acceptance ratio (PAR) and backup routing guide compliance. This is especially important under tight market conditions when the increase in costs because of primary carrier rejection and routing guide failure is higher than in soft market conditions.

Table 2 summarizes the cost impact all variables other than distance and key market areas, relative to the base case (2-5 days lead time, Medium corridor volume, Medium consistency, Zero volatility, Weekday, Non-Quarter end). There is a potential to save up to $195.9 per load by going from the worst case to the best case. This is significant considering a load from Chicago to Dallas costs $1651 on an average and a load of Dallas to Chicago costs only $1159 under base case scenario, implying cost

savings up to 11.9% and 16.9% respectively on these lanes.

Table 2. Best- and worst-case scenario for shipments based on cost per load model

Variable	Best	Savings	Worst	Penalty
Lead time	> 5 days	-$13.66	< 2 days	$41.60
Corridor Volume	High	-$25.24	Low	$20.09
Consistency	High	-$5.72	Low	$16.71
Lane Volatility	0	$0.00	2	$22.08
Weekend	No	$0.00	Yes	$22.96
Quarter End	No	$0.00	Yes	$27.84
Total		**-$44.62**		**$151.28**

As expected, factors that increase CPL tend to decrease PAR and decrease backup routing guide compliance. The findings are summarized in Table 3.

Table 3. Summary showing the direction of correlation between dependent and independent variables in the regression models

Variable	CPL	PAR	RG failure
Lead time	Negative	Negative	Negative
Corridor Volume	Negative	Positive	Negative
Lane Consistency	Negative	Positive	Negative
Lane Volatility	Positive	Negative	Positive
Weekend	Positive	Negative	Positive
Quarter end	Positive	Negative	Positive
Inbound/Outbound	--	Negative	Positive

The impact of lead time on the primary acceptance ratio, is counterintuitive to our initial view that increasing lead time increases the probability of a load getting accepted by primary carrier. A possible explanation is that the shipment may be a good network fit for the carriers and hence a higher acceptance rate irrespective of shorter lead times. It is also possible that the carriers have become sophisticated with yield management and TMS in their businesses and they are better able to handle shorter lead times. Another possible explanation is that the loads with shorter lead time are attractive to carriers in terms of their rates.

Managerial Insights

Improve lane consistency and control volatility

Lane consistency emerged as an important factor that impacts acceptance rates. Carriers are more likely to accept loads on high consistency lanes. Increasing lane volatility also tends to increase tender rejections. Shippers need to develop better demand forecasting and transportation planning in order to improve consistency and reduce volatility.

Focus attention on low volume corridors

Higher the corridor volume, lower the transportation cost and the higher the odds of tender acceptance. Hence, shippers should pay closer attention to low volume corridors as they are more prone to both Primary Routing guide failures.

Avoid weekend and quarter end pickups

Weekend and quarter end surges lead to higher costs and lower primary acceptance rates, with higher probability of the load ending up in spot market. Hence, shippers should control the weekend and quarter end surges by better scheduling their shipments.

Impact of regional sensitivity on CPL and tender rejection

If a key market area is a cheaper origin, it tends to be an expensive destination and vice-versa. However, there was no such pattern found with respect to tender acceptance rates. If a key market area has low acceptance rates as an origin, it could have any acceptance rate as a destination.

Further explore impact of lead time on costs and tender acceptance rates

This project couldn't sufficiently explain why shorter lead times are correlated with higher primary and backup acceptance rates. However, since the project established that longer lead time can lead to lower transportation costs, it's meaningful for shippers to look at their business operation and identify the opportunities of increasing tender lead time. Since carriers may accept a load if it is a good network fit regardless of the lead time, shippers could establish a strategic partnership with their carriers to help them develop their networks. Nevertheless, changing transportation operation and increasing lead time require considerable overhauling of systems and a considerable amount of time and investment. Hence, the impact of lead time is worthy to be explored further before committing to a plan of action.

Further Research

- Incorporate regional sensitivity into shippers' network design.
- Explore how market index changes the impact of lane consistency and volatility on costs and tender rejection rates. This would provide valuable insights for shippers when they are preparing for a market shift.
- Explore the effects of seasonality in demand on the costs and acceptance rates
- The reasons for shorter lead times being correlated with higher acceptance rates could be further explored by looking at other factors such as age and pricing of contracts and by looking at how carriers' capability of managing short lead time loads have changed over the years