

Development and Evaluation of Market-Based Routing Guide Strategy

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ABSTRACT

The truckload market in the United States is large, fragmented, and highly competitive. Shippers utilize routing guides to manage and tender shipments to carriers. This research examines how the macro market characteristics and micro shipper characteristics affect routing guide performance. Specifically, each key market area to key market area lane is classified into one of four characteristics based on the annual number of loads at both the macro market level and micro shipper level: Balanced, Headhaul, Backhaul, and Sparse. This capstone project addresses three main questions: Are the macro market characteristics stable over time? How does routing guide performance vary by macro market characteristics and micro shipper characteristics? What specific strategies improve routing guide performance? Our research shows that the macro market characteristics are stable over time. There are significant differences in the routing guide performance by micro shipper characteristics, but not macro market characteristics. We find that the routing guide strategy is a function mainly of what a shipper experiences, not what the entirety of the market experiences. When shippers develop a routing guide strategy, the micro shipper characteristics trump macro market characteristics. Hence, there is an opportunity to leverage the macro market characteristics for those lanes that are low-volume for a shipper but are in high-volume in macro market lanes, which represent about 53% total number of unique key market area to key market area lanes that shippers managed and 9% in total number of loads. The procurement framework we developed takes a portfolio approach by assigning specific strategies based on micro shipper characteristics and macro market characteristics. Our framework helps shippers leverage both micro shipper characteristics and macro market characteristics not only to reduce the efforts in managing transportation lanes but also to improve routing guide performance.

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- From both of us

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- Aaron

I am filled with deep gratitude and love for my wife, Vanessa, who has shown unwavering dedication and love to me, our son Gabriel, and our daughter Ariana throughout all this journey (Micromaster and Master). Without her unconditional support, I would not have been able to achieve all that I have. I am also incredibly grateful to my dear parents, Pepe, and Elsa, who instilled in me strong values and a lifelong passion for learning, inspiring me to become the best version of myself personally and professionally.

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-Jorge

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1.- INTRODUCTION

During the COVID-19 pandemic, from March 2020 to March 2022, the truckload market in the US suffered several negative impacts. The most critical impacts were that the driver shortage worsened, reaching a record high shortage of 80,000 drivers in 2021, versus ~ 55,000 pre-pandemic (*American Trucking Associations, 10/25/2021*), and that the average freight rates increased by 32% in the spot and contract market in the period between January and July 2022 compared to the same period in 2021 (*CNBC, 08/15/2022*). Given these supply chain challenges, developing adequate trucking strategies is imperative for companies to ensure that they will have enough truckload capacity to keep moving their goods within their supply chains.

The US trucking market, consisting of full truckload, less than truckload, and private/dedicated fleets, was worth ~830 billion USD in 2021. This represented 3.6% of the GDP in 2021, a 23.4% increase from 2020. The full truckload transportation segment constituted ~ 332 billion USD (Kearney, 2022). Given the trucking market's significant role in the nation's economy, it is essential to consider the complexity of this market and what makes it challenging. One reason for its complexity is how fragmented the trucking market is. According to the Federal Motor Carrier Safety Administration (FMCSA), in 2020, 88% of truckload owners had fewer than or equal to five trucks representing ~ 273 k carriers.

Furthermore, shippers typically secure annual transportation contracts through these truckloads' contracts, however are not fully binding. Although the price per lane is set, these agreements do not guarantee a specific amount of volume from the shipper or the exact capacity that the carrier will supply (Caplice, 2021). Hence, carriers can reject loads in the lanes they were awarded during the annual reverse auction; conversely, shippers do not guarantee volume. Of course, the adherence to promised volumes is closely monitored.

This complexity makes our sponsor company, C.H. Robinson, a fourth-party logistics provider (4PL), essential to its customers by connecting them with different carriers. Otherwise, this interaction with

the carriers would be a challenge for shippers. The C.H. Robinson TMC platform utilizes a routing guide, which shows the primary carrier (cost budgeted) and backup carriers for different lanes.

Once the contracts are secured, the primary carriers are embedded in a routing guide. Shippers have two options to tender their lanes when a load materializes throughout the year: using the routing guide or directly accessing the spot market. When using the routing guide, the system operates as a waterfall process where the primary carrier is offered the load first, followed by any backup carriers if the primary carrier declines. If none of the backup carriers agree to take the load, the routing fails, and the shipper can go to the spot market.

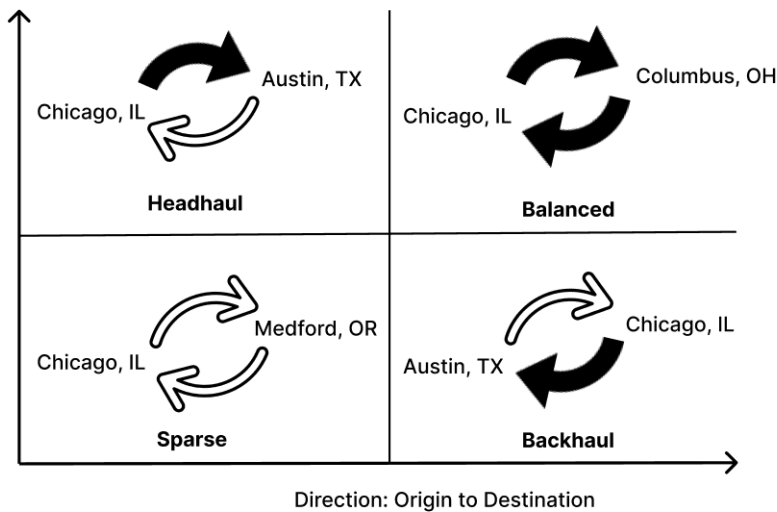
The data from C.H. Robinson between 2015 and 2022 shows that before COVID-19, the primary carrier acceptance rate was approximately 82%. However, due to the pandemic, this rate dropped to around 74%. C.H. Robinson wanted to explore if macro market characteristics impact the routing guide performance, to understand this behavior C.H. Robinson created the intelligent quadrant, which characterizes the market into four quadrants: Sparse, Headhaul, Backhaul, and Balanced, based on the volume in both directions. We define these quadrants in chapter 2. In addition to examining the macro level impacts, we also explored the micro or shippers level characteristics. The findings of this capstone project assist shippers in enhancing their Full Truck Load transportation cost strategies.

1.1.- PROBLEM STATEMENT AND RESEARCH QUESTIONS

Procure IQ, an analytical application developed by C.H. Robinson, analyzes 12 months of freight data along key market area to key market area (KMA to KMA) lanes so each lane is classified into one of four possible trucking market categories (Sparse, Headhaul, Backhaul, and Balanced) as shown in Figure 1. For each origin destination pair, there are two lanes, one in each direction. The arrow direction indicates the lane direction where the black arrow indicates high volume, and the white arrow indicates low volume. When the volume of the lane in both directions is high, it is considered “Balanced”. When the volume of the lane in both directions is low, then it is classified as “Sparse”. When only the lane from

origin to destination has a high volume, then it is considered “Headhaul.” Conversely, when only the lane destination to origin has a high volume, then it is considered “Backhaul.” Similar method is used when we categorize those KMA-to-KMA lanes into the micro shipper characteristics, but with different volume threshold and are evaluated at each individual shipper level. The definition of what constitutes of a “high” volume lane depends on whether this is a macro (market level) or micro (shipper level) perspective. Micro shipper level is 50 loads per year while CH Robinson has a higher proprietary value for macro market level. More details about the macro market and micro shipper characteristics are covered in Section 2.2.

Figure 1: Market Characteristics



As shown in Figure 1, the key market area lane from Chicago, IL to Columbus, OH and Columbus, OH to Chicago, IL both have high volume, and this lane is considered “Balanced”. The key market area lane from Chicago, IL to Medford, OR, on the other hand, has low volume in both directions, and is considered “Sparse”. For the key market area lane from Chicago, IL to Austin, TX, it has high volume from origin Chicago, IL to destination Austin, TX, but low volume from destination Austin, TX to origin Chicago, IL, therefore this lane is considered “Headhaul”. However, for the key market area lane in the

opposite direction from Austin, TX to Chicago, IL, this lane is considered as “Backhaul”, since it has low volume from the origin Austin, TX to destination Chicago, IL, but high volume from destination Chicago, IL to origin Austin, TX.

Since each characteristics has a different behavior, different approaches should be implemented to improve the corresponding truckload procurement planning results. C.H. Robinson shares this macro market characteristics information with its customers, hoping that they will leverage this information and deploy customized strategies for different macro market categories. This capstone project assessed the shipper routing guides to determine whether certain routing guide strategies improve the shipper’s truckload procurement effectiveness. The attributes of a shipment, such as lead time, drop trailer option, equipment type, are not considered in this analysis.

The capstone project’s overall goal was to provide C.H. Robinson with a list of actionable recommendations that their shippers can implement to improve their truckload procurement strategies. We hypothesized that shippers have different routing guide strategies, and that certain strategies can improve truckload procurement planning. We reviewed the literature regarding truckload procurement planning strategies and the routing guide performance, then analyzed the data to evaluate our hypothesis and offer recommendations.

This capstone project addresses three main questions: Are the macro market characteristics stable over time? How does routing guide performance vary by macro market characteristics and micro shipper characteristics? What specific strategies improve routing guide performance?

Our research shows that the macro market characteristics are stable over time. There are significant differences in the routing guide performance by micro shipper characteristics, but not macro market characteristics. The procurement framework we developed in Section 4.3 should help shippers to leverage the macro market characteristics to reduce the efforts in managing transportation lanes, and improve the routing guide performance.

The rest of this capstone is organized as follows: Chapter 2 presents a review of the research that has been conducted in this area; Chapter 3 discusses data preparation, data characteristics, and methodology used; Chapter 4 describes the data analysis results and the procurement framework we developed; Chapter 5 provides a summary and recommendations for future research.

2.- STATE OF THE ART

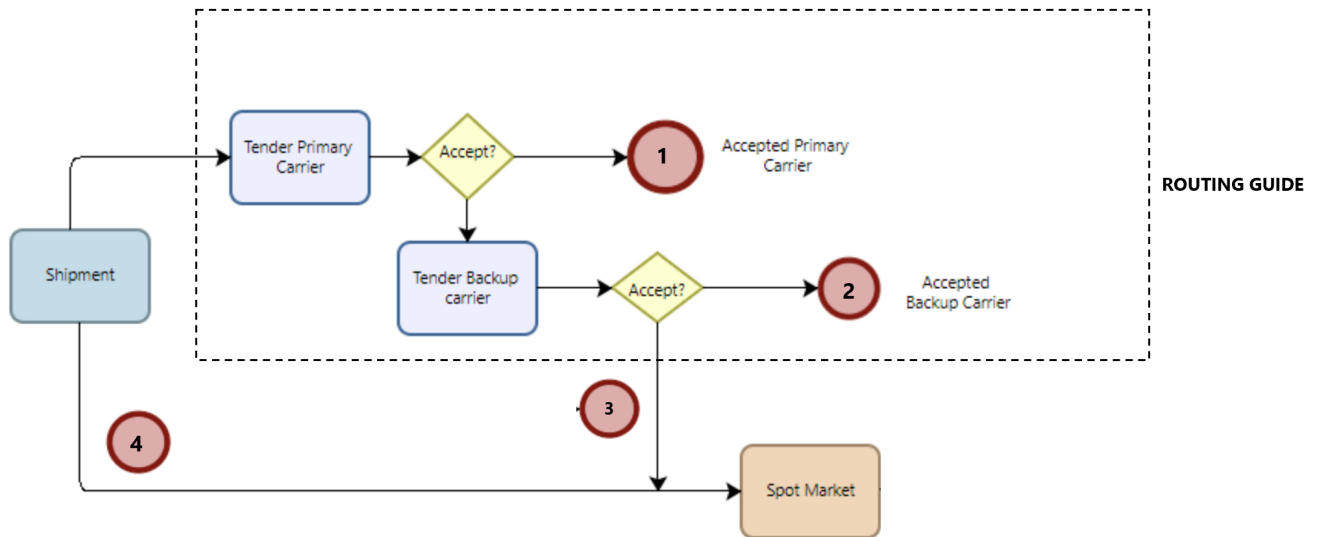
To address how macro market characteristics influences routing guide performance, we reviewed the literature in three areas: tender process, routing guide classification, and market and micro shipper characteristics.

2.1.- TENDER PROCESS

The transportation procurement process consists of two stages. The first stage is the annual request for proposal (RFP), which collects carrier bids and allocates lanes to specific carriers. The primary (winning) carrier on each lane, with the runner-up (losing) bids from different carriers listed as backups for that lane, are assigned to the routing guide that is imbedded in the transportation management system (Caplice, 2021, p. 7). Some high-volume lanes might have more than one primary carrier with the volume allocated between them. In the case of backup carriers, there is no limit to the number that can be included in the routing guide.

In the second stage, every shipment follows one of four paths to being tendered. This tender process, shown in Figure 2, follows a cascading path that starts with the primary carrier being offered the load (path 1). If the primary carrier rejects the load, it is offered to one of the backup carriers (path 2) until one agrees to take the load. If no backup carrier accepts the load, the routing guide fails, and the tender goes to the spot market (path 3). There is also the option where the shipper goes directly to the spot market without passing through the routing guide (path 4). Every shipment in our analyses follows one of these four paths. Table 1 describes these in more detail.

Figure 2: Waterfall Tender Process with 4 Paths



According to the data from C.H. Robinson, the average routing guide acceptance rate has been about 92% over the last 8 years. However, there are two tender options that bypass the routing guide: customer direct booking and direct to the spot market. In customer direct booking, the shipper tenders the load to a specific carrier that is not included in the routing guide. Our capstone project does not address this option, but we found that shippers also consider it in their tender process. In direct to the spot market, the shipper bypasses the routing guide carriers and works with the current dynamic of the market, which determines the freight rates. This is path 4 discussed earlier.

Table 1: Path Classification’s description

Path #	Name	Path Description
1	Primary	The primary carriers accept the tender for the load.
2	Back-up Carrier	The load is rejected by all primary carriers but accepted by a subsequent carrier within the routing guide.
3	Routing Guide Failure - Spot	The load is rejected by all carriers in the routing guide, then moved to the spot market for tenders.
4	Spot Market	There is no carrier set up in the routing guide, and the load goes directly into the spot market for tender.

Freight rates tend to vary depending on the selected tender option. Primary carriers have an agreed upon rate that shippers consider in their annual budget. These carriers are the winners from the request for proposal (RFP) auction process, such as performance level, carrier capacities, and other selection logic (Aemireddy & Yuan, 2019). Aemireddy and Yuan (2019) further observed that moving from the primary carrier to the first backup carrier increased the freight rate from 4.4% to 5.3% during 2015 to 2018 (Aemireddy & Yuan, 2019, p. 20). This changes overtime, of course. The spot market prices are uncertain because they depend on the market, which can be either tight or soft. As a result, the freight rate can fluctuate.

2.2.- MACRO MARKET AND MICRO SHIPPER CHARACTERISTICS

Various studies have used TMC data from C.H. Robinson regarding the performance of the routing guide. However, these studies have focused on analyzing how various load characteristics impact the routing guide's performance across different scenarios from a perspective that differs from that of our capstone project.

Aemireddy and Yuan (2019) examined the performance effects of tender lead times, distance, regional sensitivity, lane consistency, and volatility. The study found a connection between reduced lead times

and increased primary acceptance rates and expenses. Consistency in lanes played a crucial role in reducing the rejection of tenders. Furthermore, the research identified regional sensitivity as a significant factor that affects carrier rates and the probability of tender rejection.

Alnajdawi and Jimenez (2020) examined routing performance analysis by selecting three types of shippers (high, medium, and low volume) and classifying the lanes into five categories Planned - On budget, Planned- Over budget, Planned - Over budget, Unplanned - Over budget, and Ghost, Planned- Under Budget. This study discovered that temperature control lane freight loads result in more significant budget deviations, whereas dry van loads tend to cause lower budget deviations. The research also revealed that the origin and destination of shipments could influence budget deviations based on the shipper. In addition, volume deviations were found to impact budget overruns more than price deviations significantly.

Caza and Shekhar (2022) evaluated the resilience of the routing guide throughout special and disruptive events such as holidays, hurricanes, and seasonality. The showed that routing guides exhibit varying performance levels during disruptive events, presenting opportunities for shippers to enhance their routing guide performance on less busy lanes and their decision-making processes regarding the utilization of the spot market. In addition, by understanding routing guide performance during freight disruptions, shippers can optimize their freight networks regarding volume and cost management.

In our capstone, we analyze the performance of the routing guide, but, for the first time, look at how the macro market conditions influence how shippers manage their lanes using the four macro market characteristics determined by C.H. Robinson (Sparse, Headhaul, Backhaul, and Balance) using brokerage data (Figure 3).

2.2.1.- MACRO MARKET CHARACTERISTICS

C.H. Robinson uses the following steps to classify each KMA-to-KMA lane into one of four market quadrants:

1. Aggregate the number of loads by origin and destination pair at key market area lane level over a 12-month period. For each origin and destination pair, find the number of loads for its matched return key market lane “destination to origin” pair. For instance, origin to destination as Chicago to Miami will have Miami to Chicago as destination to origin. Any origin to destination pair that for which the loads for the matched destination to origin pair cannot be found will be considered as 0 load.
2. Calculate the density of the origin to destination lane by scaling the number of loads flowing each origin and destination.
3. Calculate the density of the destination to origin lane by scaling the number of loads each destination and origin pair has.
4. Create the four quadrants by plotting the load/density of the destination and origin pair in X-axis, and the density of the origin and destination as Y-axis.
5. Set the middle point of the axis at specific numbers of loads determined by the sponsor company in the X and Y axis. The units at the left side in the X axis and at the downside in the Y axis of the middle point are in total loads units per key market area lane (linear).

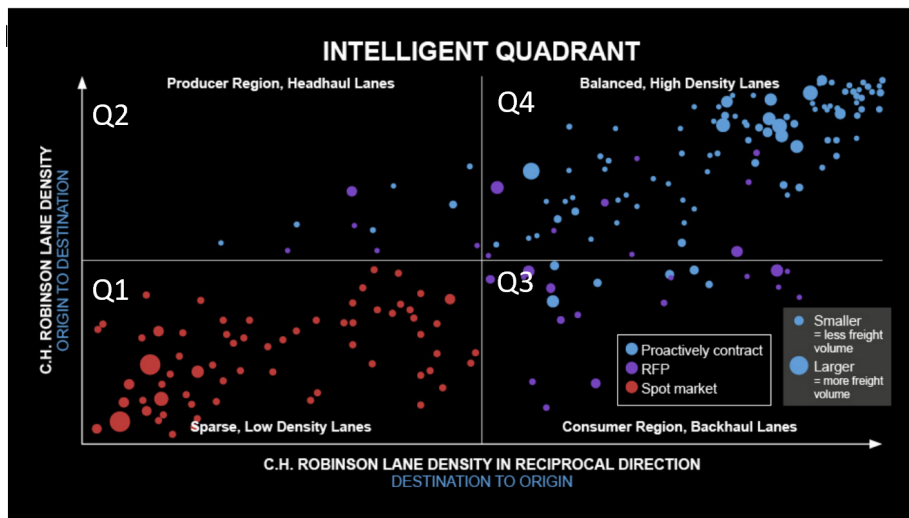
On the other hand, the units at the right side in the X-axis and at the upside in the Y-axis of the middle point (\geq threshold number of loads) are not linear but are based on density of the key market area lane volume.

Based on this logic, the 2-dimensional diagram (see Figure 3), the definition of the four macro market characteristics is as follows:

- **Q1:** Sparse Key market area Lanes: these OD pairs have low volume in both directions.

- **Q2:** Headhaul Key market area Lanes: The Origin to Destination Lane has high volume while the Destination to Origin Lane has low volume.
- **Q3:** Backhaul Key market area Lanes: the opposite of Q2. Origin to Destination has an annual load that is smaller than the middle point of loads, and the Destination to Origin has an annual load that is greater or equal to the middle point of loads.
- **Q4:** Balanced Key market area Lanes: both Origin to Destination and Destination to Origin have annual load greater or equal to the middle point of loads.

Figure 3: Procure IQ Macro Market Characteristics

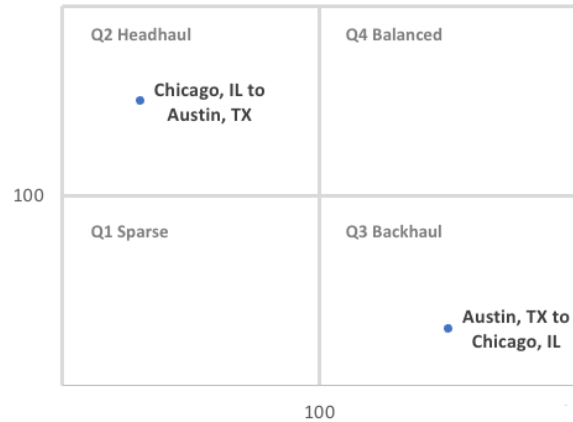


Note. Figure 3 shows the four-macro market characteristics into quadrants in a two-dimensional diagram. Source, <https://www.chrobinson.com/en-us/technology/robinson-labs/procure-iq/>

For filling in the information in this macro market characteristics diagram, it is critical to consider that every KMA-to-KMA pair has two dots in the diagram depending on the origin to destination and vice versa. For instance, if we draw the key market area lane from Chicago, IL to Austin, TX, it will have a second dot from Austin, TX to Chicago, IL, assuming a hypothetical high-volume threshold of 100 loads (see Figure 4).

Figure 4: Example Drawing Dots with Backhaul and Headhaul Lanes

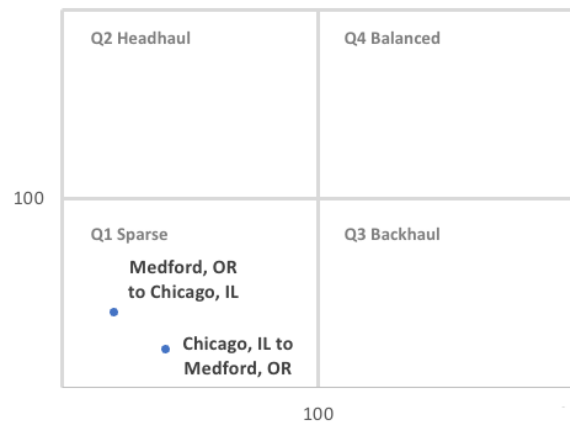
Lane	Number of Loads		Quadrant
	X axis	Y axis	
Chicago, IL to Austin, TX	150	30	Headhaul
Austin, TX to Chicago, IL	30	150	Backhaul



Chicago, IL to Medford, OR is a second example in the Sparse quadrant. It will have a second dot (from Medford, OR to Chicago, IL) assuming a hypothetical middle point of 100 loads (see Figure 5) also in the sparse quadrant.

Figure 5: Example Drawing Dots with Sparse Lanes

Lane	Number of Loads		Quadrant
	X axis	Y axis	
Chicago, IL to Medford, OR	20	40	Headhaul
Medford, OR to Chicago, IL	40	20	Backhaul



2.2.2.- MICRO SHIPPER CHARACTERISTICS

Using the same logic as the macro market characteristics stated in the previous section, we replicated the four quadrants at the shipper level. The only two differences between the macro market and the

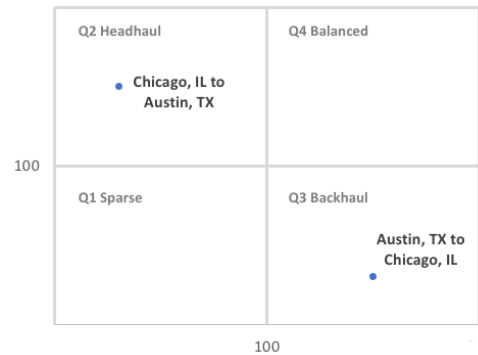
micro shipper characteristic are the threshold for annual volume and the source of the truckload volume included: The entire C.H. Robinson volume or a single shipper's volume. We set 50 loads as the high-volume threshold in the intelligent quadrant's axes.

Figure 6 illustrates the difference between Macro and Micro perspectives. This demonstrates that while a lane might be in a headhaul quadrant at the overall market level, it could be in a totally different quadrant from that shipper's micro-level perspective.

Figure 6: Difference Between Macro market characteristics and Micro shipper characteristics

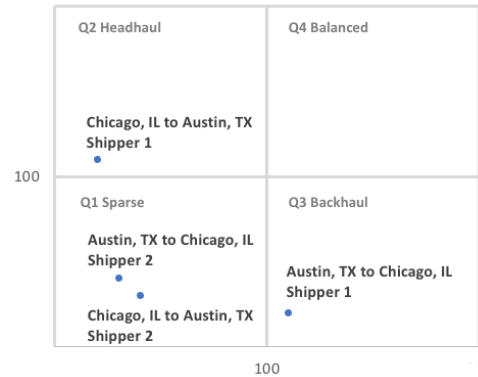
Macro Market Characteristics

Lane	Number of Loads		Quadrant
	X axis	Y axis	
Chicago, IL to Austin, TX	150	30	Headhaul
Austin, TX to Chicago, IL	30	150	Backhaul



Micro Shipper Characteristics

Lane	Shipper	Number of Loads		Macro Market Characteristics	Micro Shipper Characteristics
		X axis	Y axis		
Chicago, IL to Austin, TX	1	20	110	Headhaul	Backhaul
Austin, TX to Chicago IL	1	110	20	Backhaul	Headhaul
Chicago, IL to Austin, TX	2	40	30	Headhaul	Sparse
Austin, TX to Chicago IL	2	30	40	Backhaul	Sparse



Micro shipper characteristics are crucial because it enables us to view the shipper individually, regardless of the market volume at the consolidated lane level. By analyzing shipper performance per lane, we can determine whether shippers should consider market volume when tendering their loads by comparing it to the overall market performance.

As we showed in the Results and Discussion section, utilizing this new approach of segmenting the four quadrants based on both the micro shipper and macro market characteristic levels prove highly beneficial. It facilitates comparisons and proposals of different strategies using the macro market characteristics and the micro shipper characteristics.

3.- DATA AND METHODOLOGY

In this chapter, we described the methodology we used to clean the data provided by C.H. Robinson, apply the business rules, define the evaluation periods, and evaluate the macro market characteristic stability.

3.1.- DATA PREVIEW

This capstone examined the truckload shipment C.H. Robinson TMC data from 2015 to 2022. It included the load transactions (physical movement of shipments), tenders (tenders offered to carriers to move shipments), cost quotes (routing guide information), and a macro market characteristic by key market area based on C.H. Robinson brokerage data. This study considered only those shipments that were long-haul (≥ 250 miles) dry vans in the US.

The load transactions dataset included load, shipper, origin, destination, mileage, awarded tender sequence, shipment pickup date, and the list of fields that are used to determine the primary carrier.

The tender's dataset contained the load number, the sequence number (routing guide depth), the quote identification, and the tender status (accepted or rejected). The cost quotes dataset was the routing guide information, it included shipper, carrier, quote identification, origin, destination, linehaul cost, and the list of fields used to determine the primary carrier. Each quote identification in the cost quote dataset represented a specific lane from a specific carrier. Lastly, the macro market characteristic dataset used origin and destination of each lane and matches to the key market area, then provides x-axis and y-axis coordinates that were mentioned in Section 2.2 Macro Market and Micro Shipper Characteristics.

3.2.- EVALUATION PERIODS

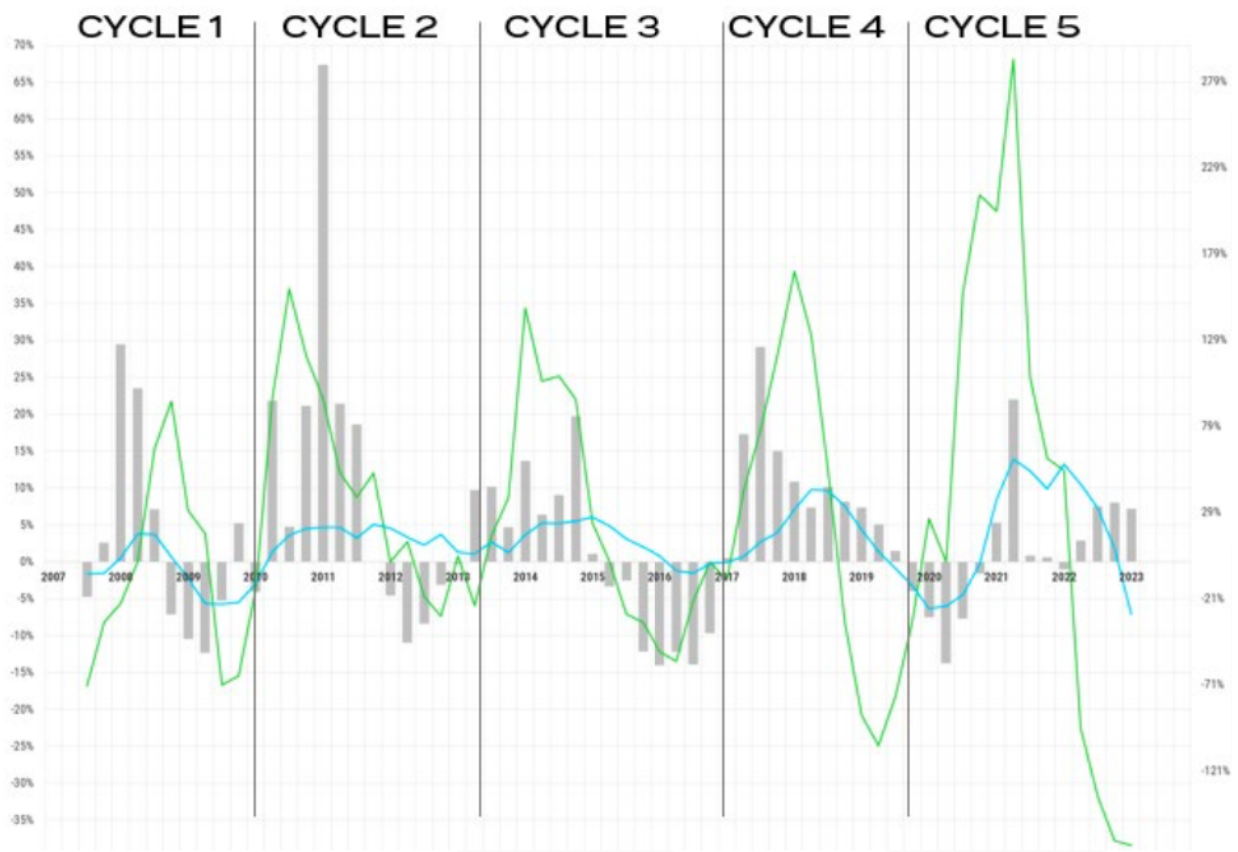
From 2015 to 2022, the trucking industry had passed through various phases or periods. As we explained in Chapter 2, there are two distinct market cycles: a tight market cycle, characterized by higher freight rates, and a soft market cycle, marked by overcapacity in the market and a subsequent

decrease in freight rates (Figure 7). It is important to consider these market cycles when analyzing and comparing the routing guide performance across different macro market characteristics as well as when proposing alternatives for how shippers can enhance their strategies regarding its performance.

Figure 7: Spot and Contract Truckload Market Cycles

Coyote Curve (TL Spot Market Rate) | **Cass Linehaul Index (TL Contract Market Rates)** |

ACT U.S. Net Class 8 Tractor Orders (Secondary Axis)

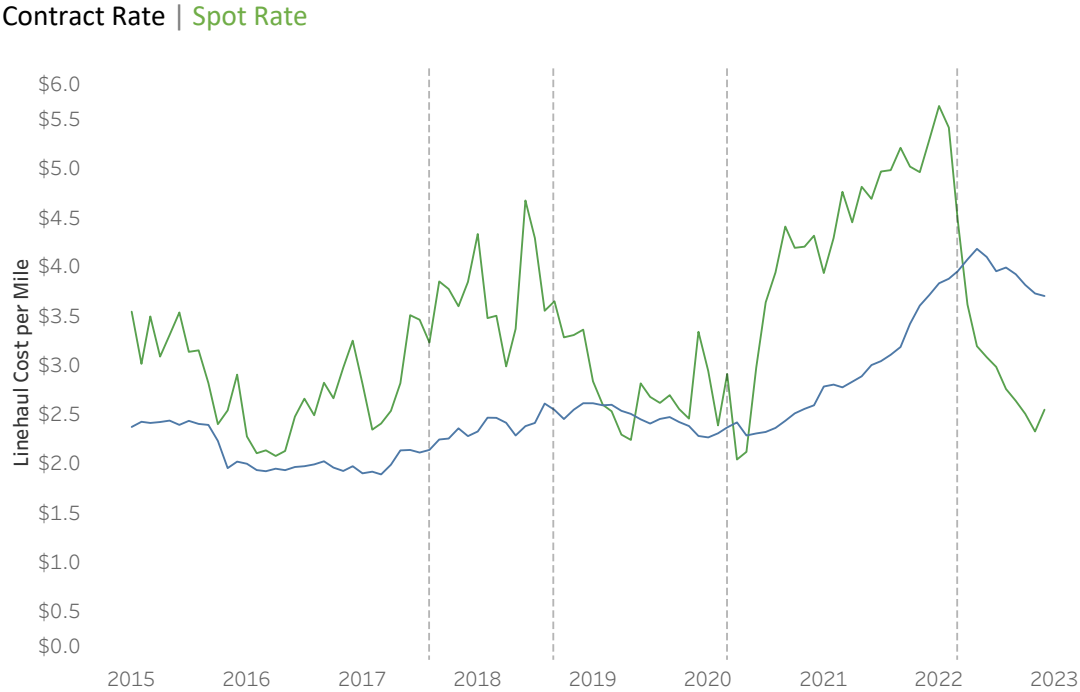


Note. This figure shows the cyclical trend of the Truckload market from 2007-2023. Source: coyote.com

After considering these market cycles, we examined our data by tracking the cost per mile over time and observed comparable cycles (as depicted in Figure 8). As a result, we determined to divide these market cycles into four distinct evaluation periods, namely pre-COVID tight market, pre-COVID soft market,

COVID, and post-COVID, to conduct more comprehensive analyses and gain valuable insights into shippers' strategies. First, we considered the pre-COVID soft market period from January 2015 to August 2017 and October 2018 to February 2020. By the end of 2018, a freight recession occurred, and the market remained soft until COVID hit. The second, pre-COVID tight market, was from September 2017 to September 2018. The US truckload market faced extremely tight conditions and higher rates over a decade before the Covid pandemic (Bandaru & Dolci, 2020). Last, COVID and post-COVID period was considered from March 2020 to March 2022, and after March 2022 respectively. Indeed, to determine the beginning of the COVID 19 pandemic, we considered that in March 2020, the president of the United States declared a National Emergency (*Coronavirus*, timeline, US Department of Defense).

Figure 8: COVID Evaluation Periods vs. Cost per Mile



3.3.- DATA CLEANSING

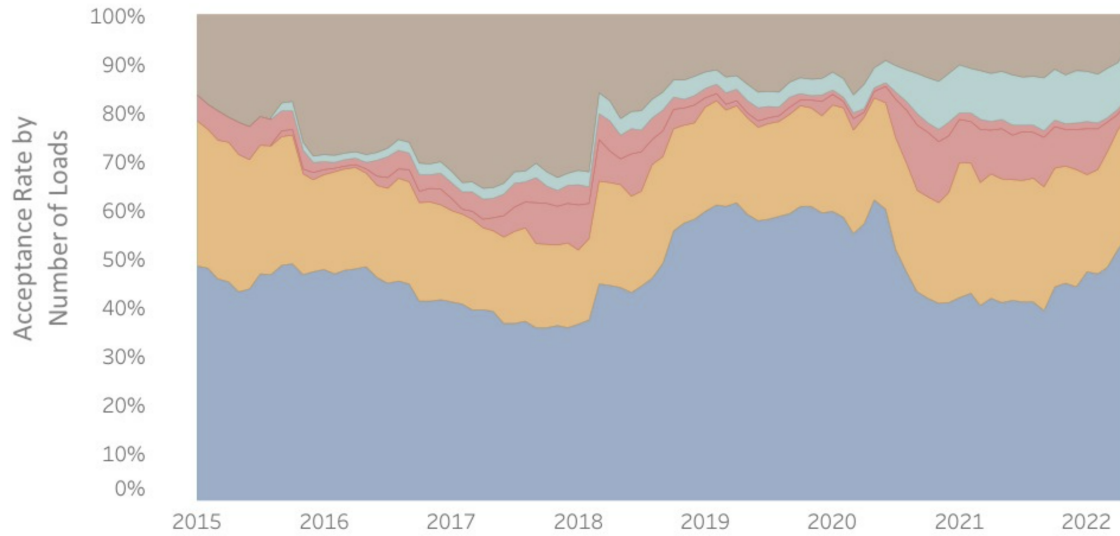
The following steps were performed to cleanse the data and to remove any field or record not within this capstone's scope.

- Select only relevant columns from each data source to reduce the file size.
- Filter out any missing information in the key fields.
- Filter out any shipment that cannot find a matched key market area.
- Filter out any shipment with mileage less than 250.
- Filter out any shipment with the mileage greater or equal to 3000.

The percentage of shipments by path classification revealed a significant change in tendering in March 2018 due to customer turnover (Figure 9). These customer turnovers in March 2018 resulted a significant decrease in the number of shipments that classified as "Customer Direct Booking", which dramatically increased the percentage of the shipment belong to any path classification other than "Customer Direct Booking". Since this was a special event results a change in the path classification pattern, we decided that this capstone should focus on reviewing the data for only the top 20 shippers that had consistent volume over the past 8 consecutive years, with the average number of annual loads greater than 1,000.

Figure 9: Historical Classification with All Shippers

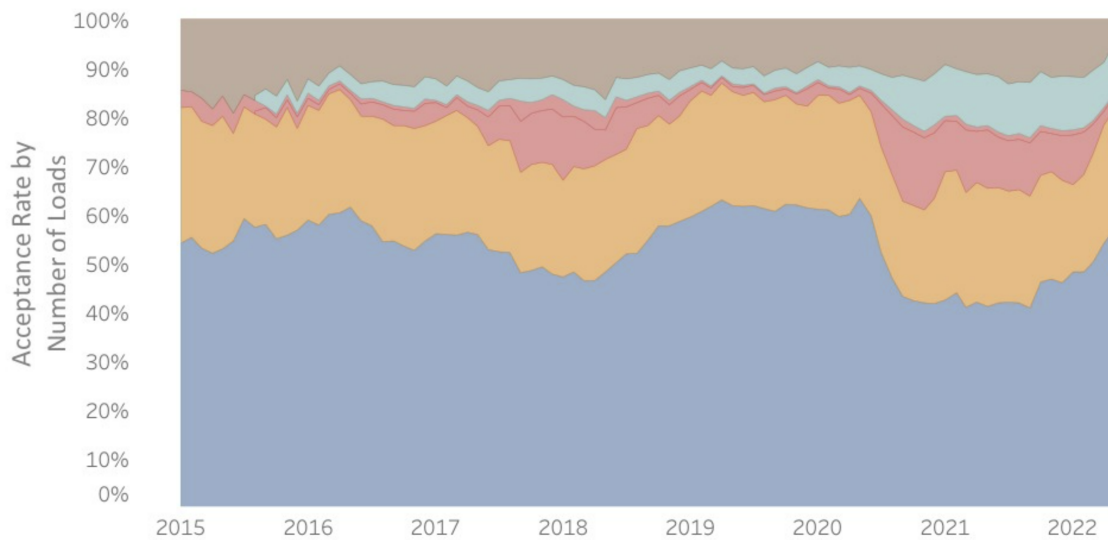
Primary | Back-up Carrier | Routing Guide Failure | Spot Direct | Customer Direct Booking



After removing unrelated shippers, the historical path classification was matched with the market cycle (Figure 10). The dip in the Primary acceptance rate starting in June 2020 was due to the COVID pandemic. Lastly, any shipment data with the path classification “Customer Direct Booking” also got excluded, since these shipments did not go through the routing guide.

Figure 10: Historical Classification with Top 20 Shippers

Primary | Back-up Carrier | Routing Guide Failure | Spot Direct | Customer Direct Booking



3.4.- STABILITY AND METHODOLOGY

Before examining whether the routing guide performance affects the macro market characteristics, we needed to determine whether they are stable over time at KMA-KMA lane level. When the macro market characteristics are stable, it helps to isolate the impact of the macro market characteristics change results in a change in the routing guide performance. To effectively evaluate the macro market characteristics stability, both Numeric Quadrant Movements and Euclidean Distance formulas were used to determine whether the macro market characteristics changes over time.

C.H. Robinson generated the macro market characteristics based on its rolling 12-month brokerage data at the key market area (KMA) to key market area (KMA) lane level. Each KMA-to-KMA lane had its own x and y to represent the macro market characteristics based on the business rules mentioned in Section 2.2 Macro Market and Micro Shipper Characteristics. Each shipment was provided with an origin to destination pair at the city state level; then these origin and destination pairs were matched to key market area to key market area lane to find the corresponding macro market characteristics, and all the volumes were aggregated to the KMA-to-KMA lane level.

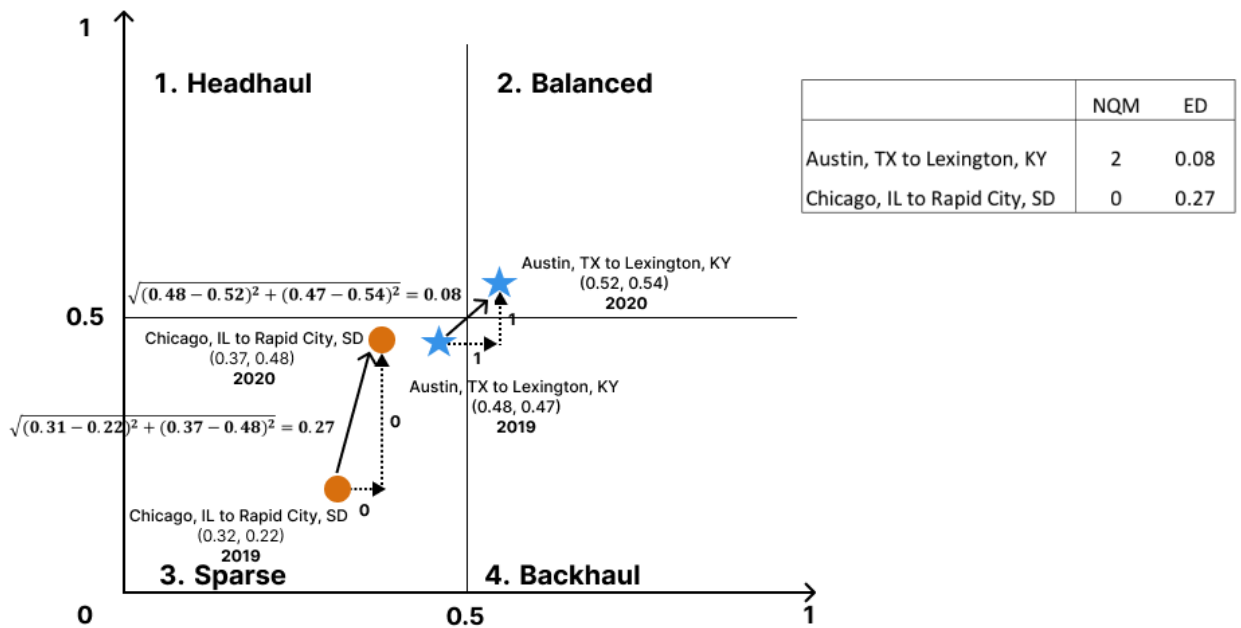
As shown in Table 2, Chicago, IL to Miami, FL lane had an x coordinate of 0.89 and y coordinate of 0.65 for 2019, and 0.87 and 0.54 for 2020. Based on the macro market characteristics discussed in Section 2.2 Market and Micro shipper characteristics, this lane was in Quadrant 2 and classifies as “Balanced” for both 2019 and 2020.

Table 2: Stability Methodology Examples

KMA to KMA Lane	Numeric Quadrants			Euclidean Distance		
	2019	2020	Movement	2019	2020	Euclidean Distance
Chicago, IL to Miami, FL	2	2	0	(0.89, 0.65)	(0.87, 0.54)	0.10
Chicago, IL to Duluth, MN	1	2	1	(0.55, 0.41)	(0.53, 0.51)	0.10
Chicago, IL to Rapid City, SD	3	3	0	(0.31, 0.22)	(0.37, 0.48)	0.27
Austin, TX to Lexington, KY	3	2	2	(0.48, 0.47)	(0.52, 0.54)	0.08

The first method, “Numeric Quadrant Movements” (NQM), was used to assign each KMA (key market area) pair a numeric quadrant to represent its corresponding macro market characteristics: Headhaul as Quadrant 1, Balanced as Quadrant 2, Sparse as Quadrant 3, and Backhaul as Quadrant 4

(see Figure 11). Then, it compared whether the numeric macro market characteristics movement from year to year. If it did change, when the numeric macro market characteristics moved from 1 to 4, or 4 to 1, or 2 to 3, or 3 to 2, the macro market characteristics were considered to move by 2 quadrants movement. Otherwise, the macro market characteristics were considered to move by 1 quadrant. For the remaining KMA-to-KMA pair that did not change, the macro market characteristics were considered to move by 0 quadrants. As shown in Figure 11, the KMA lane Austin, TX to Lexington, KY from 2019 to 2020, it moved 2 quadrants, one quadrant to the right and one quadrant to the top, from Quadrant 3 to Quadrant 2. In comparison, Chicago, IL to Rapid City, SD moved 0 quadrant, since it stayed in the same quadrant. Figure 11: Numeric Quadrant Movements and Euclidean Distance Change



In the second method, a Euclidean Distance equation (Equation 1) was used to calculate the distance based on the density information provided by CH Robinson, where each key market area lane had its own x and y coordinates. Since the exact x and y coordinates for each KMA-to-KMA pair by year were provided, Equation 1 was used to calculate the distance change year over year. The Euclidean

Distance for lane Chicago, IL to Rapid City, SD and lane Austin, TX to Lexington, KY from 2019 to 2020 were shown in Figure 11. Once the distance change for each KMA- to-KMA was obtained, the average and the standard deviation of the distance could be calculated and determine whether there was a significant change in macro market characteristics from year to year.

These two methods complement each other. For those lanes in the edge of the quadrant, a small move in position might result in a big movement in the numeric quadrant, such as the KMA lane Austin, TX to Lexington KY in Figure 11. Similarly, those lanes might have the same quadrant but have a big difference in Euclidean Distance, such as the KMA lane Chicago, IL to Rapid City, SD in Figure 11. Hence, we must combine the methods to accurately capture the change in the macro market characteristics and allow us to effectively evaluate the stability of the macro market characteristics over time.

Equation 1 *Euclidean Distance Equation*

$$Euclidean\ Distance = \sqrt{(x_{last\ year} - x_{this\ year})^2 + (y_{last\ year} - y_{this\ year})^2}$$

After we examined the stability of the macro market characteristics, we evaluated routing guide performance. To assess whether any routing guide strategy works better in a specific quadrant, we first evaluated the acceptance rate by path classification at the macro market characteristics by shipper, then used hypothesis testing to examine whether there was a significant difference in the performance. In addition, we also evaluated the acceptance rate by path classification down to the micro shipper characteristics. Then, we used hypothesis testing to examine whether there was a significant difference in performance.

Examining the routing guide performance metrics through the lenses of both the macro market and the micro shipper characteristics allowed us to understand whether there was a difference in performance in different quadrants.

Lastly, we examined the routing guide depth down to macro market and micro shipper characteristics, which measured the number of the tenders each load needs to submit till it got accepted by the carrier. The first tender always went to the primary carrier, and a lower average number of tenders indicates a better performance.

To minimize the influence of the overall market condition, we not only evaluated these performance metrics mentioned above at the macro market and micro shipper characteristics, but we also separated the data into different periods based on the overall market conditions. The Results and Discussion chapter explained how we evaluated the stability of the macro market characteristics, as well as our data analysis results based on these performance metrics as well as our recommendations.

4.- RESULTS AND DISCUSSION

To address the central problem of our capstone — How do macro market characteristics influence routing guide performance? — we used the methodology described in the previous chapter to analyze

the data provided by C.H. Robinson to examine three main aspects: (1) Stability, (2) Performance metrics, and (3) Strategies.

4.1.- STABILITY

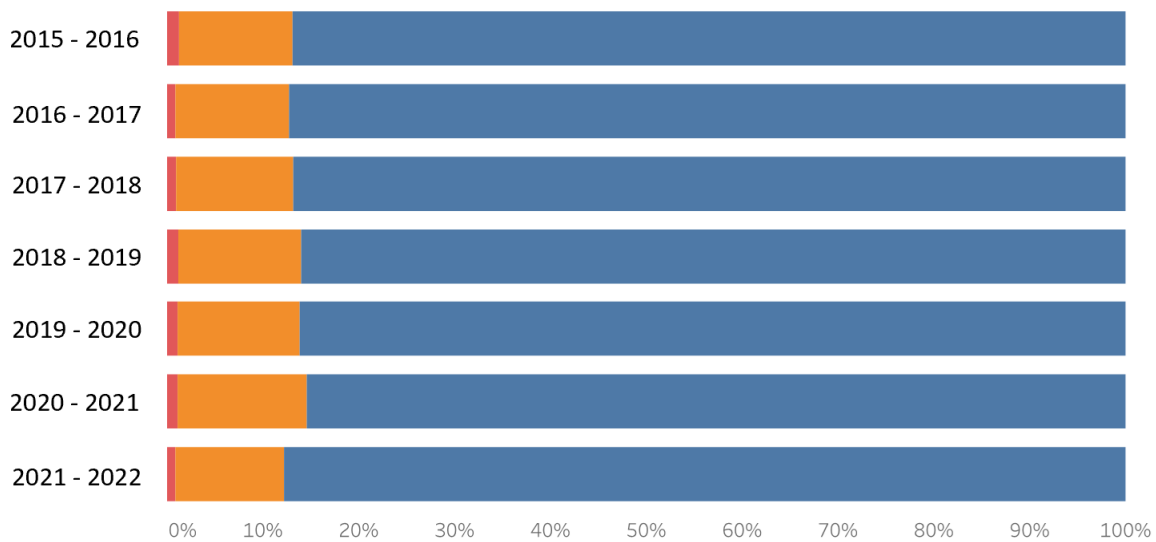
Due to the cyclical nature of the trucking industry, which can affect metrics measured across macro market characteristics at the KMA-KMA lane level, we verified whether the lanes were stable over time and what lanes were stable within each COVID period (pre-COVID tight market, pre- COVID soft market, COVID, and post- COVID). Then, based on these findings, we proceeded with our analysis to propose enduring strategies that remain relevant over time.

As stated in Chapter 3 Stability and Methodology (section 3.4), we used the Euclidean distance average method to confirm the stability of the key market area lanes over time. Four graphs (Figures 12-15) present the findings, demonstrating consistency over time and during COVID periods.

Figure 12 displays the yearly percentage of quadrant movements per KMA-KMA lane, divided into three categories: Numeric quadrant move (NQM) = 2, NQM = 1, and NQM = 0. Our findings show that lanes remain stable over time, with an average quadrant movement per KMA-KMA lane of 0.12. We found that the majority of lanes (88.5%) had NQM = 0 meaning they stayed in the same quadrant. About 11% of lanes had NQM =1 and less than 1% (0.5%) had NQM = 2.

Figure 12: Numeric Quadrant Change

Numeric Quadrant Move (NQM) = 2 | NQM = 1 | NQM = 0



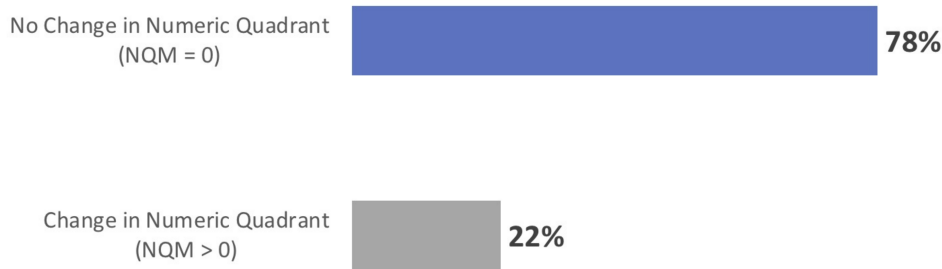
Second, it is essential to work with stable lanes that rarely change over time and have no change during any evaluation period stated in section 3.2 (pre-COVID tight market, pre- COVID soft market, COVID, and post- COVID) because we had to analyze performance across the four market quadrants without the influence of a macro market characteristics change. In Table 3, we can see three examples that illustrate these cases: The first example is the lane from origin A to destination B, categorized as "No change in Numeric Quadrant, NQM = 0." This category indicates that the KMA-KMA lane belongs to the balanced quadrant from the start and maintained it throughout the years. The second example is the lane from origin Y to destination Z, categorized also as "No change in Numeric Quadrant, NQM = 0." Here, we can observe that the lane initially belongs to the balanced quadrant, but its macro market characteristics changed over time. However, during each of the 4 evaluation periods, the macro market characteristics remained constant. Finally, the lane from origin F to destination J is categorized as "Change in Numeric Quadrant, NQM > 0." This category indicates that the lane's macro market characteristics were in flux both between and within the four evaluation periods.

Table 3: Stability per Macro market characteristics Over Time – Cases

		MACRO MARKET CHARACTERISTICS - QUADRANTS												
Lane	Category	Pre-Covid Soft			Pre-Covid Tight		Pre-Covid Soft			COVID			Post - Covid	
		2015	2016	2017 Jan - Sept	2017 Oct - Dec	2018 Sept	2018 Oct - Dec	2019	2020 Mar	2020 Apr - Dec	2021	2022 Mar	2022 Apr - Actual	
A to B	No Change in Numeric Quadrant (NQM=0)	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	
Y to Z	No Change in Numeric Quadrant (NQM=0)	Balance	Balance	Balance	Headhaul	Headhaul	Headhaul	Headhaul	Headhaul	Balance	Balance	Balance	Headhaul	
F to J	Change in Numeric Quadrant (NQM>0)	Headhaul	Balance	Headhaul	Headhaul	Headhaul	Headhaul	Balance	Balance	Balance	Sparse	Backhaul	Backhaul	

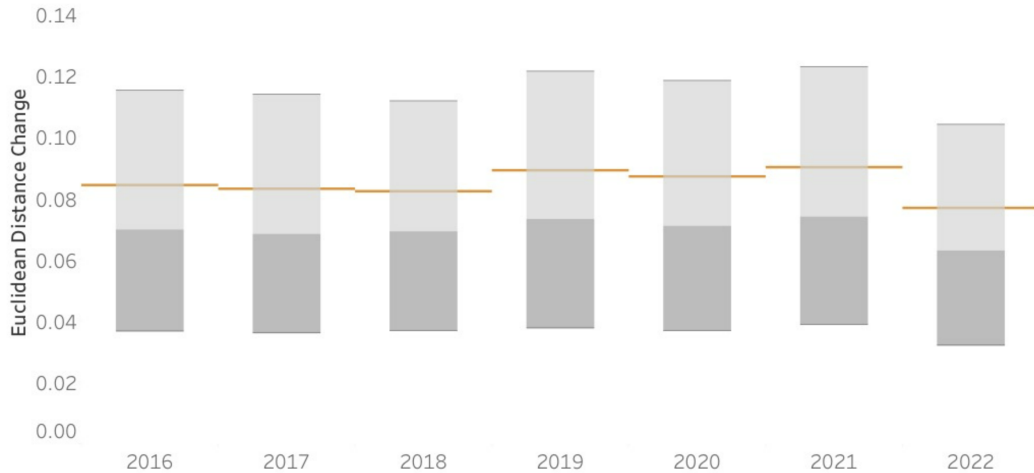
Figure 13 shows the distribution of KMA-KMA lanes by these 2 categories. We can see that 78% had no change in numeric quadrant.

Figure 13: Changes Over Time



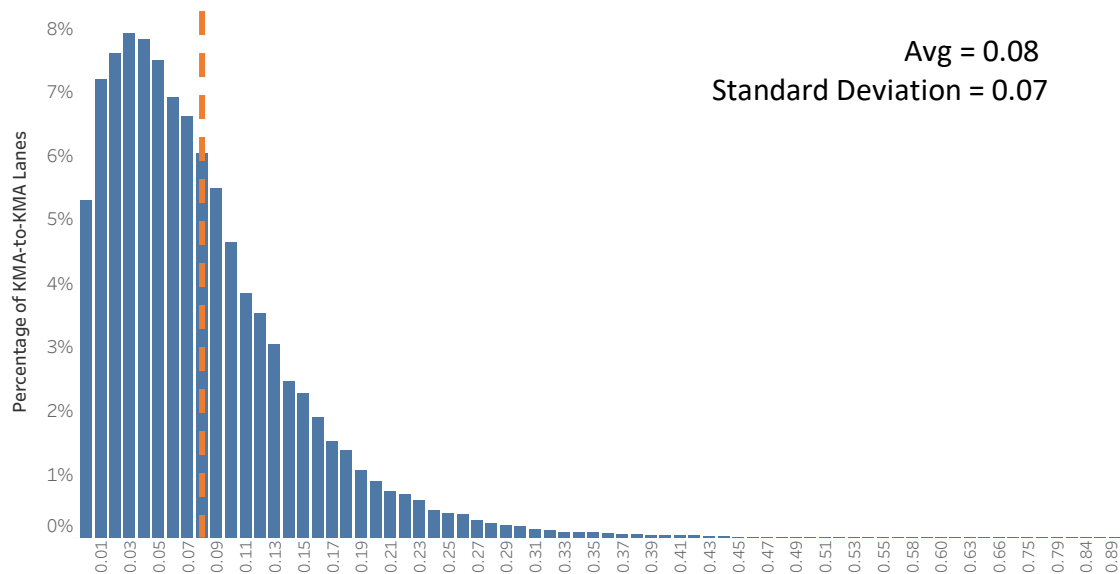
Third, we used a boxplot graph (Figure 14) to show the inner 50 percentile (gray bar) and the mean of the Euclidean distance change compared to the previous year (orange line). This indicates how compact the changes are at the key market area lane volume level. We obtained an average Euclidian Distance change of ~ 0.08 across all KMAs, meaning that the macro market characteristics of KMA-KMA lanes were stable over time. In this boxplot graph, the X axis is the time yearly, and the year represented the comparison against the previous year. For instance, 2016 indicates the Euclidian Distance Changes of all the dots, representing the macro market characteristics of KMA-KMA lanes in the diagram of the four quadrants, from 2015. The Y axis represents the Euclidean distance change with a range from 0 (no changes) to 1 (drastic change of macro market characteristics).

Figure 14: Euclidean Distance Change



Last, we used a histogram (Figure 15) to reinforce the idea that the Euclidean Distance changes year over year from 2015 to 2022 in the macro market characteristics of KMA-KMA lanes were stable over time. Indeed, the distribution of these changes was skewed to the left (X axis equals 0) with a long tail to the right, which meant most KMA-KMA lanes had small changes over time that could be movements at the same quadrant level (macro market quadrant).

Figure 15: Euclidean Distance Change Distribution



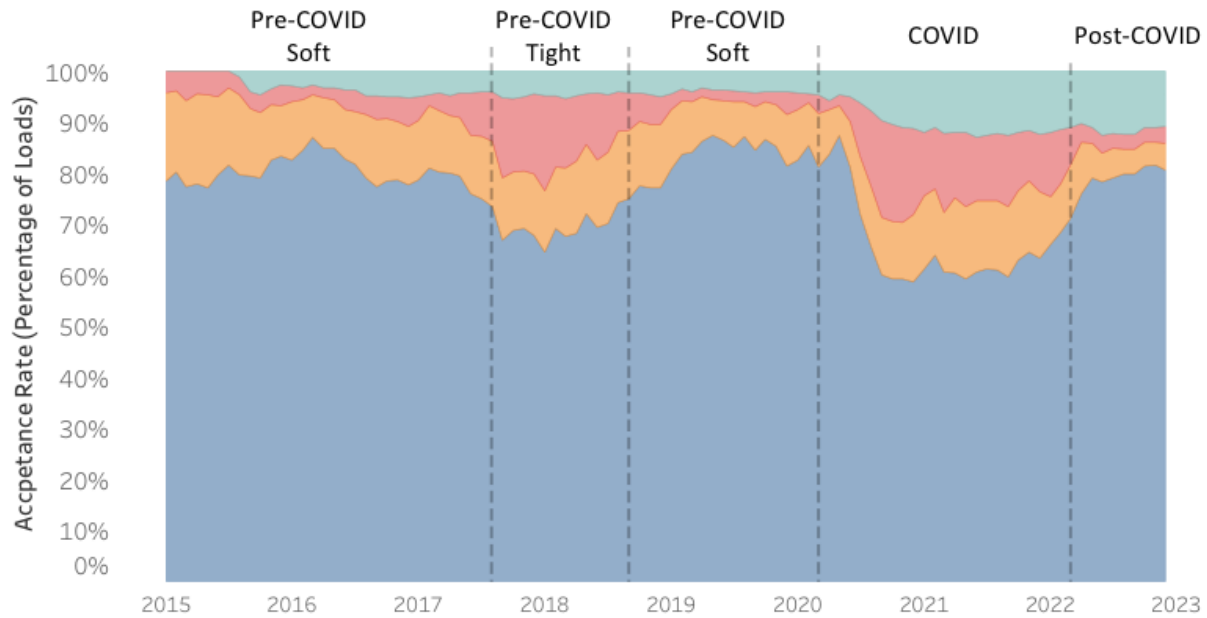
Our findings suggest that the macro market characteristics of KMA-KMA lanes remain consistent over time. Our analysis is supported by three key metrics: the average Numeric Quadrant Movement is 0.12, 78% of all KMA-KMA lanes do not change numeric quadrant, and the average Euclidian Distance change across all KMAs is ~ 0.08 . The remainder of our analysis uses those KMA-KMA lanes where NQM = 0.

4.2.- PERFORMANCE

Establishing that macro market characteristics are stable allows us to evaluate routing guide performance without the influence of market changes. In this section, we examine the acceptance rate, the routing guide depth, the number of loads, and the percentage of KMA-to-KMA lanes by using path classification, explicitly looking into the different macro market and micro shipper characteristics and different evaluation periods.

As expected, we find that the routing guide's performance is heavily dependent on the overall macro market characteristics (see Figure 16). When the market is soft (Pre-COVID Soft, Post-COVID), the primary carrier acceptance rate is high. When the market is tight (Pre-COVID Tight, COVID), the primary carrier acceptance rate is low. Because of this, we assess the routing guide performance by each of the different evaluation periods (Section 3.2).

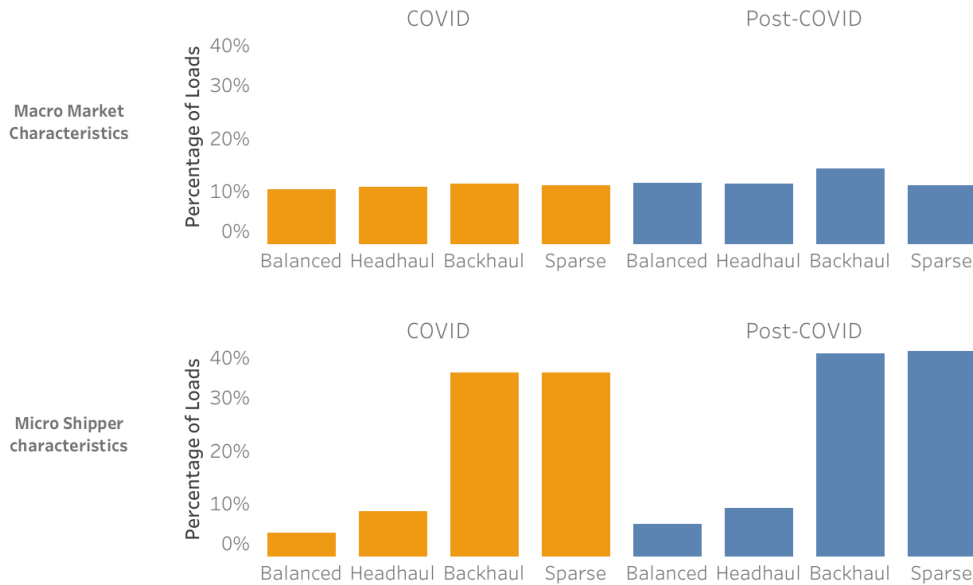
Figure 16: Historical Acceptance Rate by Path Classification



In addition to the overall market condition impacting the routing guide’s performance, we notice that shippers started using more Direct to Spot at the beginning of the COVID pandemic in March 2020. Increasing from ~4% to over 12%. Interestingly, this practice has remained since then. Further, while there is no significant difference in the percentage of Direct to Spot across the four macro market quadrants, there is a significant difference at the micro shipper level (see Figure 17).

Specifically, there is a 25% higher chance of using Direct to Spot on Backhaul and Sparse lanes (at the micro shipper level) compared to Balanced and Headhaul. This is not the case at the macro market level and suggests that micro shipper characteristics trump macro market characteristics. The routing guide strategy should reflect what the shipper experiences within their network, not what the entirety of the market experiences. Additionally, we found that more shippers started leveraging Direct to Spot to avoid spending unnecessary effort on managing Backhaul and Sparse lanes to achieve similar or better performance.

Figure 17: Percentage of Direct to Spot by Macro Market and Micro Shipper Characteristics

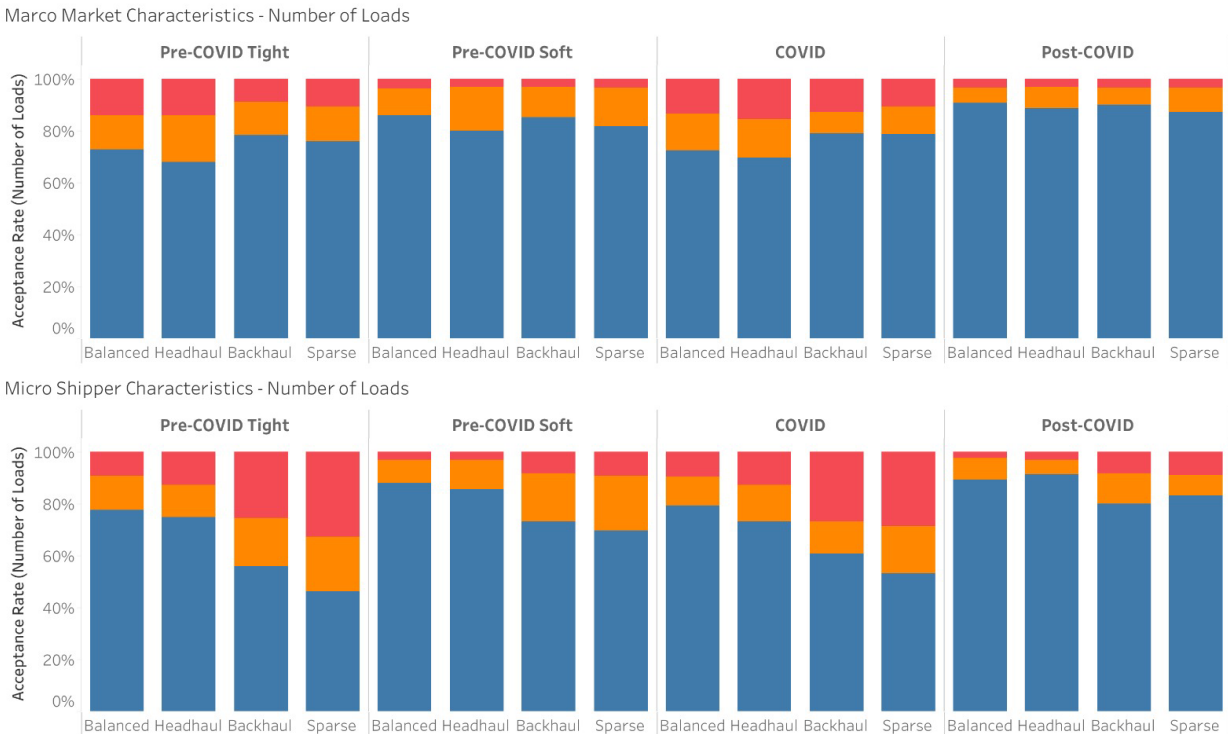


We divided our dataset into the four different evaluation periods mentioned in Section 3.2: Pre-COVID Tight, Pre-COVID Soft, COVID, and Post COVID. Then we examined whether the acceptance rates significantly varied by macro market characteristics in each period. The original hypothesis for this project was that the performance of the routing guide varied by the macro market characteristics. However, the data shows (see Figure 18) that there is less than 6% difference in the primary carrier acceptance rate across the macro market characteristics in all evaluation periods. There is no significant difference in the performance of the routing guide in different macro market characteristics. This was a surprising finding, which made us hypothesize that the shippers paid more attention to their own micro shipper characteristics, based on their historical volumes, and expected to see different performance by micro shipper characteristics. The result shown in Figure 18 confirms our new hypothesis: we find there is a significant difference in the routing guide performance in terms of the micro shipper characteristics. Specifically, over 30% difference in the primary acceptance rate across different micro shipper characteristics during the period “Pre-COVID Tight”, 18% difference during the period “Pre-COVID Soft”, 26% difference during the period “COVID”, and 11% during the period “post-COVID”. Regardless of the

overall market condition, the acceptance rate for those KMA-to-KMA lanes in the micro shipper characteristics Balanced and Headhaul is at least 8% higher than those lanes in the Backhaul and Sparse.

Figure 18: Acceptance Rate by Number of Loads across Different Characteristics and Evaluation Periods

Primary | Back-up Carrier | Routing Guide Failure



We find that the acceptance rate generally follows this order except for the post COVID period:

Balanced key market area lane performed better than Headhaul, Headhaul performed better than Backhaul, and Backhaul performed better than Sparse. Based on these findings, we conclude that the shippers pay less attention to the macro market characteristics when they make procurement decisions. Instead, they make procurement decisions based on the historical or anticipated demands they foresaw in the next procurement period.

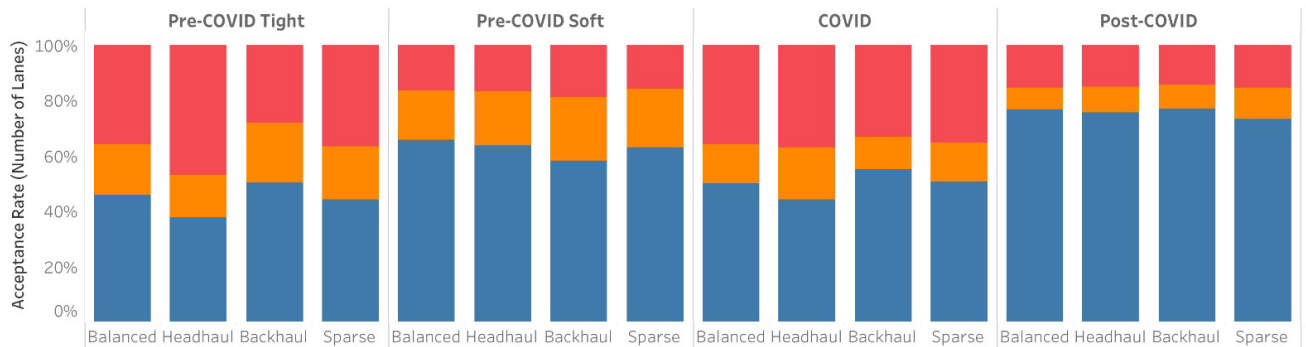
One limitation of the above method of calculating acceptance rate based on different characteristics and evaluation period is that the high-volume key market area lane might dominate the

performance of that characteristics. Hence, we decided to remove the impact of the volume, and evaluate the key market area lane performance with each key market area lane represented with the same weight. After removing the impact of the volume, we find similar results (see Figure 19): there is minimal significant difference in key market area lane performance across macro market characteristics, but a significant difference in the micro shipper characteristics. Additionally, those KMA-to-KMA lanes belonging to Balanced and Headhaul tend to perform much better than Backhaul and Sparse. This finding suggests that a key market area lane tends to perform well when there is a consistent volume from origin KMA to destination KMA (average one load per week), and even better when the key market area lane have significant volume in both direct directions (average one load per week in both origin KMA to destination KMA and destination KMA to origin KMA).

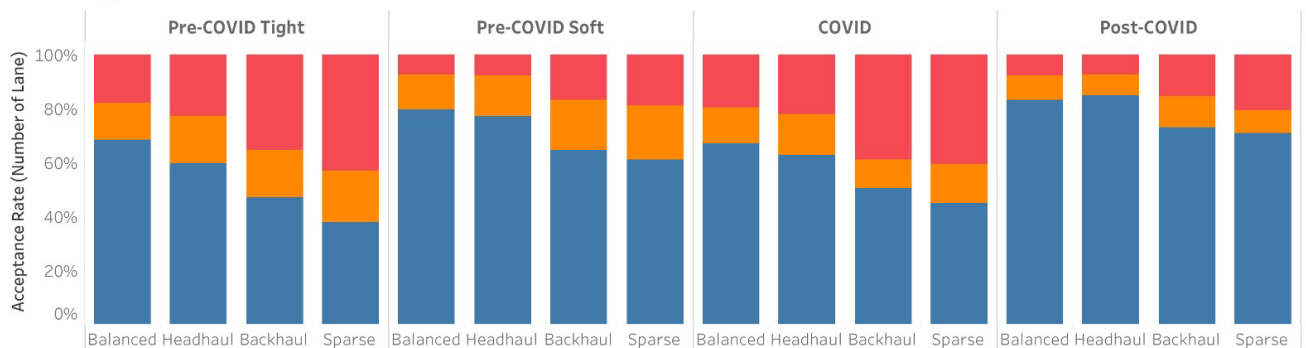
Figure 19: Acceptance Rate by Number of Unique KMA Lanes across Different Characteristics and Evaluation Periods

Primary | Back-up Carrier | Routing Guide Failure

Macro Market Characteristics at KMA-to-KMA Level



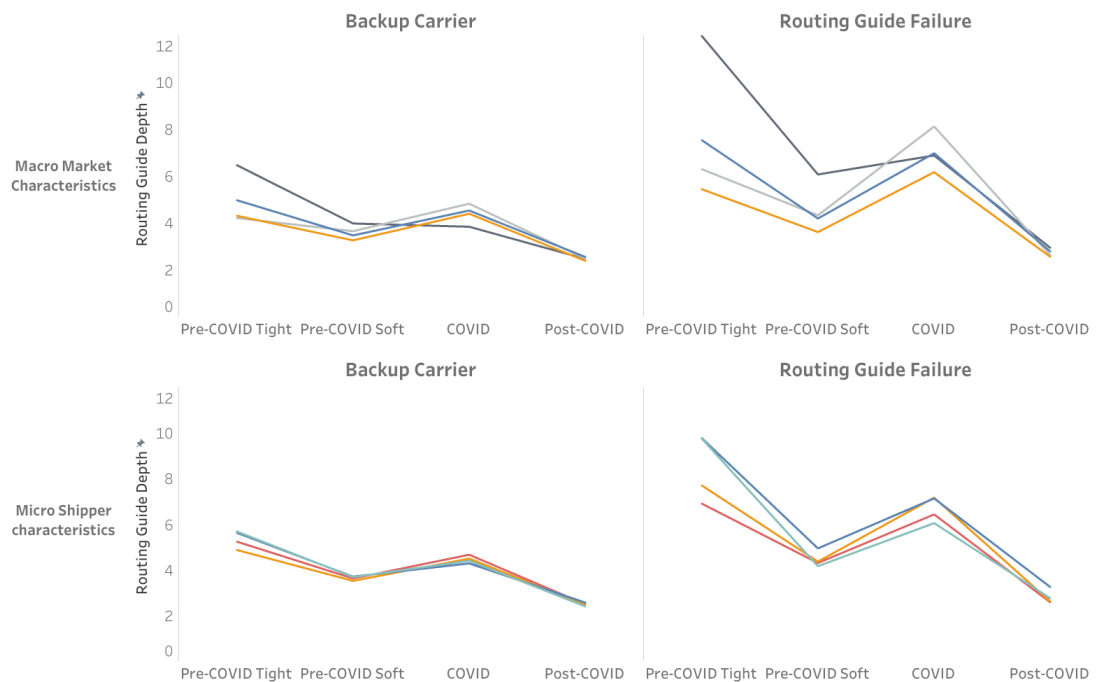
Micro Shipper Characteristics at KMA-to-KMA Level



After examining the acceptance rate by different characteristics and evaluation periods, we reviewed the routing guide depth, which measured the average number of tenders per load sent out before a load was accepted. The lower routing guide depth indicates the load is accepted faster. We specifically looked into those loads that were either accepted by the backup carrier or rejected by all carriers in the routing guide. We find that there is no consistently significant difference among macro market characteristics or micro shipper characteristics (see Figure 20). Instead, the average routing guide depth is driven by the overall market conditions. When the overall market condition is soft, the average routing guide depth tends to be lower. When the overall market condition is tight, the average routing guide depth tends to be higher. However, the average routing guide depth during Pre-COVID Tight is much higher than the COVID period. This suggests that shippers might have learned their lessons and implemented a better strategy to manage their routing guides when the overall market condition is tight.

Figure 20 Routing Guide Depth by Macro Market and Micro Shipper Characteristics

Balanced | Headhaul | Backhaul | Sparse



Knowing that the acceptance rate of Balanced and Headhaul lanes tended to be better than Backhaul and Sparse lanes, and that shippers tended to focus more on their micro shipper characteristics than the macro market characteristics, we believed there was an opportunity to leverage the macro market characteristics and improve the routing guide performance.

To assess this opportunity, we created two matrixes to show the number of loads and the number of unique KMA to KMA lanes classified by macro market characteristics and micro shipper characteristics based on the data in 2022 (see Table 4). It appeared that only 29% of loads are on lanes that had the same macro market and micro shipper characteristics, and 8% of loads previously classified as Backhaul (1%) and Sparse (7%) through the lens of shippers were classified as Balanced in the macro market characteristics, and 1% of loads previously classified as Backhaul and Sparse through the lens of shipper were classified as Headhaul in the macro market characteristics. There is an opportunity to leverage the macro market characteristics to improve the acceptance rate for those 53% KMA lanes or 9% loads that are Backhaul and Sparse in micro shipper characteristic but Balanced and Headhaul in macro market characteristic, as we find that those Balanced and Headhaul lanes performed better than Backhaul and Sparse lanes.

Table 4: Micro Shipper vs. Macro Market Characteristics by Number of Loads and KMA Lanes

		Micro Shipper Characteristics				
Macro Market Characteristics		Balanced	Headhaul	Backhaul	Sparse	Grand Total
Number of Load	Balanced	22%	40%	1%	7%	70%
	Headhaul	2%	5%	0%	1%	8%
	Backhaul	1%	3%	0%	1%	5%
	Sparse	8%	7%	0%	2%	17%
	Grand Total	33%	55%	1%	11%	100%

		Micro Shipper Characteristics				
Macro Market Characteristics		Balanced	Headhaul	Backhaul	Sparse	Grand Total
Number of KMA Lanes	Balanced	4%	12%	5%	41%	62%
	Headhaul	0%	2%	0%	7%	9%
	Backhaul	0%	1%	1%	6%	8%
	Sparse	1%	3%	1%	16%	21%
	Grand Total	5%	18%	7%	70%	100%

We found that only 23% of lanes fell in the same macro market and micro shipper quadrants while 46% of lanes were classified as Backhaul or Sparse at the micro shipper level but as Balanced at the macro market level.

As shown in Table 4, 23% of the lanes classified as Balanced or Headhaul at shipper level made up about 88% of total annual loads. 41% of lanes that were previously classified as Sparse at the micro shipper level but were Balanced at the macro market level, and made up 7% of total annual loads; 12% of lanes that were previously classified as Headhaul at micro shipper level but was Balanced at the macro market level, and made up 40% of total annual loads.

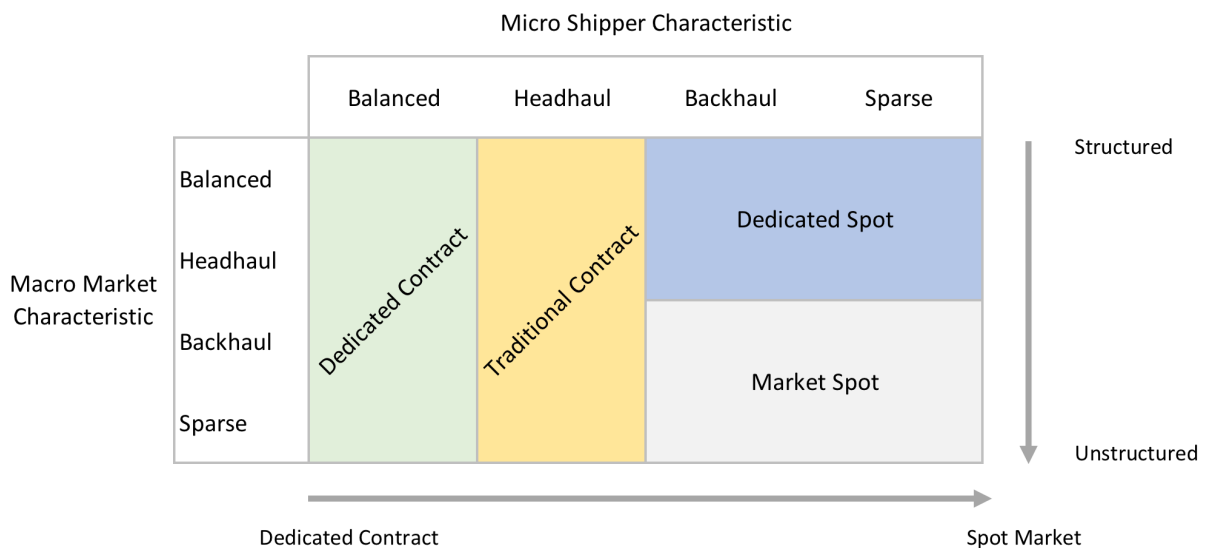
Shippers should dedicate most of their resources in managing those 23% of lanes that are Balanced or Headhaul in their network, since these lanes drove the overall spend and performance given their high volumes. For Backhaul and Sparse lanes, shippers should develop a strategy that minimizes their efforts.

After determining that those lanes that are Balanced and Headhaul at the micro shipper level outperformed those lanes in Backhaul and Sparse by at least 8%, and realizing that there was a mismatch in the micro shipper and macro market quadrants, there is an opportunity to leverage the macro market characteristics to improve the acceptance rate for those lanes that classified as Backhaul or Sparse at the micro shipper level but Balanced or Headhaul at the macro market level. Based on the data shown in Table 4, approximately 53% of the total lanes and 9% of the overall volumes fell into those mismatched quadrants, and shippers can leverage the procurement framework that we developed to achieve a higher acceptance rate. The strategy discussed in the next section helped shippers minimize the efforts for those low volume key market area lanes while still achieving comparable or better performance.

4.3.- STRATEGY

In this section, we discuss our procurement framework. Our framework is divided into four different categories (see Figure 21) based on the micro shipper and macro market characteristics. Dividing lanes into four different categories allows shippers to apply a different strategy in each category. The type of resources that shipper should secure shifts from dedicated to spot market as the micro shipper characteristics shifts from Balanced to Sparse. Furthermore, the macro market characteristics affects the level of detail in the contract: when the macro market characteristics lean toward Balanced and Headhaul, the contract should be more structured; when it leans toward Sparse and Backhaul, less structured. The procurement framework we developed takes a portfolio approach by using the dedicated contract, traditional contract, dedicated spot, and market spot based on different micro shipper and macro market characteristics. It provides shippers with general guidance; the mid-point of 50 loads per week that we used to draw the border of micro shipper characteristics is defined arbitrarily rather than according to any hard rules.

Figure 21: Procurement Framework



Dedicated Contract: A contract that allows a shipper to secure dedicated resources for a specific number of loads for a particular lane from a carrier at an agreed upon rate, with the carrier committing 100 percentage of the acceptance rate. There is a penalty for the party that failing to fulfill the commitment.

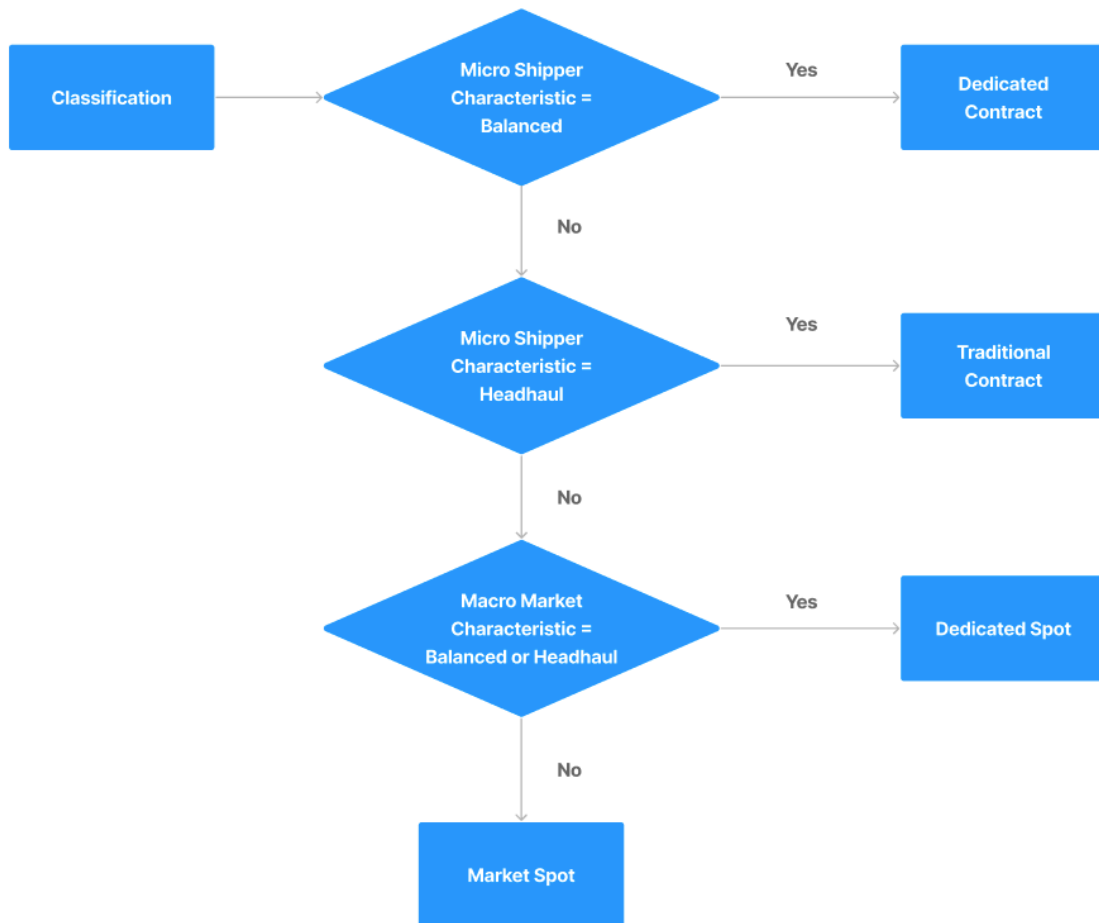
Traditional Contract: A contract that allows a shipper and carrier to agree on a specific number of loads for a particular lane at an agreed upon rate, but there is no penalty for either party that fails to completely fulfill the commitment.

Dedicated Spot: A contract that allows a shipper to pay a carrier according to some external index pricing for a specific lane that has been manually agreed upon.

Market Spot: Shippers send their loads directly to the spot market, and shippers and carriers agreed upon the rate based on a load-to-load basis.

Our procurement framework suggests that a shipper should procure based on its own volume regardless of how that lane behaves across the market, except for those lanes in the micro shipper characteristics Backhaul and Sparse. The process flow map in Figure 22 illustrates our procurement framework decision making process.

Figure 22: Strategy Framework Flow Chart



First, any lane that is classified as Balanced at the micro shipper level, high volume and predictable in both directions, should pursue a dedicated contract solution. Dedicated contract solution requires shippers pay some form of fixed and variable (per mile) rate to a carrier for a given time period (month, quarter, year), or use those carriers that have long-term relationship. By having dedicated resources in these lanes, shippers maximize the acceptance rate for those lanes while achieving cost effectiveness.

Second, any lane that is classified as Headhaul at the micro shipper level, high volume only in the direction from origin to destination, should implement the traditional contract solution. Since these lanes still have high volume in the direction from origin to destination, carriers are willing to dedicate

resources to these lanes. The traditional contract solution involves shipper and carrier set a binding price per load (cost per mile or cost per load) for a given time period (usually annual) but the volume is not totally guaranteed to materialize and the capacity is not totally guaranteed to be provided. By having the traditional contract, shippers take advantage of volume consistency and market competitiveness to not only lower the contract rate but also achieving good acceptance rate.

Third, we divide those lanes that are classified as Backhaul or Sparse at the micro shipper level into two different categories. The first category, any lane that is low volume (Backhaul or Sparse) at the micro shipper level but high volume (Balanced or Headhaul) at the macro market level. About 53% of the total lanes fell into this category and only represented 9% of total volume (see Table 4). We recommended the shippers to use the dedicated spot strategy for these lanes, which entails the shipper and carrier agreeing on a price per load (cost per mile or cost load) for a given time period (usually annual) that is based on a mutually agreed 3rd party index pricing. Because the carriers have visibility at the macro market level, they are more willing to accept on those lanes that are Balanced or Headhaul at the macro market level, especially when the price is matched with the market. This dedicated spot strategy helps the shippers to minimize the efforts managing 53% of total KMA-to-KMA lanes, but also achieve a higher performance.

Lastly, shippers should use the market spot strategy for the remaining lanes are considered low volume in both micro shipper and macro market levels. These lanes make up 24% of the total lanes, but only 3% of the overall volume (see Table 4). Instead of setting up the carriers for those lanes in the routing guide, we recommend that shippers send those loads directly to the spot market whenever they need it. Because these lanes have low volume and may not have repeated volume, they are unlikely to have a significant impact on the overall performance, so shippers should minimize their efforts in managing these lanes.

With the procurement framework we developed, shippers can categorize their lanes into four different categories and apply different strategies. This approach not only helps shippers manage their lanes more effectively but also improves routing guide performance.

5.- CONCLUSION AND RECOMMENDATIONS

5.1.- KEY FINDINGS

In our capstone project, we used the Intelligent Quadrant developed by CH Robinson, in which lanes are classified into four macro market categories (Balanced, Headhaul, Backhaul, and Sparse) to determine the stability of the lanes over time and the difference between the performance of the macro market vs. micro shipper characteristics. We have three key findings:

The macro market KMA-KMA lanes tend to be stable over time. In general, KMA-KMA lanes exhibit high stability over time and rarely change quadrants. The observed stability of these macro market characteristics provides a valuable foundation for drawing conclusions regarding performance and for proposing practical strategies to enhance routing guide performance and, from the shipper's perspective, the management of their lanes.

Routing guide performance across macro market quadrants is not statistically different. Our analysis revealed a notable similarity in performance across the four macro market quadrants during each period. Hence, we deduce that no discernible differences in the strategies employed for shippers exist at the macro market level.

Routing guide performance across micro shipper quadrants is statistically significant. Through our analysis of the routing guide performance for each evaluation period at the micro shipper level, we noted that lanes in the balance and head haul quadrant exhibit superior performance compared to the backhaul and sparse lanes. This observation leads us to conclude that shippers prioritize their micro-shipper characteristics over macro-market characteristics when making transportation procurement decisions.

5.2- AREAS FOR FUTURE RESEARCH

We suggest conducting the following three research studies to further investigate the data provided by C.H. Robinson and improve our proposed strategies:

- Our capstone project relies on data analysis provided by C.H. Robinson. Nevertheless, it would be beneficial to also gain insights from the shipper's perspective. To achieve this, we propose supplementing our analysis with interviews with the most successful shippers to comprehend their decision-making process regarding the routing guide.
- As a part of our methodology, we focused on stable key market area lanes because we believed that their consistency over time would enable us to develop more effective strategies. However, a question to be explored in the future is why specific key market area lanes are unstable over time and how we can approach them to suggest strategies for shippers.
- Over time, the spot market has developed and is now viewed as a strategic component by many shippers. As a result, it would be beneficial to study how shippers access this market. For instance, to analyze the different types of contracts or the decision-making processes that shippers employ when participating in this market.

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APPENDIX

Figure A.A.

PATH CLASIFICATION:

When “Quote ID” is null, it indicates the load is not accepted by the carrier in the routing guide. When “Spot Bid Flag” equals 1, it means the load is accepted by spot market carrier. Additionally, when “Sequence Number” equal to 0, it indicates the load goes directly to the spot market. Otherwise, the load goes to the routing guide first, but it fails then goes to the spot market.

When “Quote ID” is null and “Spot Bid Flag” equal to 0, that means the load is handled by the specific carrier that shipper has asked C.H. Robinson to use for that specific load. When “Sequence Number” equals 0, it indicates the load does not go through the routing guide, the shipper provides the carrier information to C.H. Robinson when initiates the load. Otherwise, the load does go through the routing guide, but fails then the customer provides the specific carrier for that load. Since any load with “4b. Consumer Direct Booking” does not go through the routing guide, and the shipper asks C.H. Robinson to use a specific carrier for the load. Hence, this path classification is excluded from this capstone research.

