Shippers' Behavior Study Through Developing and Calibrating their Utility Functions

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16. Abstract

This study addresses the lack of granularity in traditional freight demand models by developing a comprehensive survey to collect disaggregated data on freight movements and the underlying logistics decisions made by shippers. The primary objective was to enhance the precision of freight demand forecasts and gain a deeper understanding of the complexities within freight transportation networks. The survey targeted logistics managers and shippers, gathering detailed information about their firms, including the types and volumes of goods, as well as the specific characteristics of individual shipments. This disaggregated data enabled the construction of utility-based models that examine shipper decision-making from a granular perspective, revealing the factors influencing transportation mode and route selection. Building upon the survey insights, the study implemented several key advancements: (1) developing localized models for individual commodity or industry categories; (2) incorporating geographical features, such as distance between origin and destination zones, to improve predictive accuracy; (3) comparing the performance of machine learning ensemble models and utility function-based approaches, including multinomial logistic regression and nonlinear classification models, achieving over 92% accuracy in mode prediction; and (4) creating a freight transportation dashboard to visualize and interpret key transportation data and trends. Addressing the common issue of data imbalance in freight logistics, the study employed machine learning techniques to manage skewed distributions across different commodities and transportation choices. These efforts collectively enhance the ability to predict and interpret freight movement, supporting the planning and operations of more efficient multimodal transportation systems. The findings from this study provide a foundation for improving freight demand forecasting and transportation planning, enabling stakeholders to make more informed decisions that promote sustainable and effective freight mobility across the nation.

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Executive Summary

Freight demand models often possess an aggregate nature, leading to a lack of sensitivity to the nuanced changes in logistics behavior among decision-making units like firms. The primary aim of Project 5 of the FERSC initiative is to study shippers' behavior by developing and calibrating their utility functions. In this project, a survey was designed to gather information about how shipments move nationwide and to understand the logistics decisions made by shippers. One of the key objectives is to collect data that reveals shipper behavior, with the survey targeting logistics managers and shippers to uncover the characteristics of their firms, including the types and volumes of incoming and outgoing goods.

To understand each firm's logistics decisions, the survey asks detailed questions about shipments. Disaggregate logistics choice models require in-depth information on individual shipments as well as the decision-making actions of firms. To address the shortcomings of existing freight demand models, this study developed a comprehensive survey aimed at improving data collection on freight movements.

This survey aims to enhance the precision of freight demand forecasts and provide a deeper understanding of the complexities of freight transportation networks by focusing on the logistics decisions and transportation choices made by individual firms. The growing volume of freight movements and their impact on socio-economic systems, particularly transportation, emphasize the need for accurate tools to evaluate commodity flows and predict future trends. However, the reliance on basic, aggregate models by many state and local governments limits the effectiveness of current freight demand forecasting methods. This study overcomes these limitations by collecting disaggregated data on freight movement, emphasizing the practical decisions made by firms in the United States.

An important data source for this study was the 2017 Commodity Flow Survey (CFS) from the U.S. Census Bureau, which includes over 6 million records providing rich shipment-level information such as commodity type, industry classification, origin-destination points, and shipment distances. This data allowed for the construction of utility models that examine shipper decision-making from a disaggregate perspective, enhancing understanding of the factors influencing transportation mode and route selection. There are many challenges in using the CFS data, including: (1) the origin/destination is not a specific location but a large zone; (2) alternative modes between a given origin/destination pair may not be complete in the dataset; (3) missing attributes that might be important in the utility function; and (4) others.

Key advancements in this study include four main areas of improvement: (1) constructing localized models specific to each commodity or industry category to capture unique characteristics; (2) incorporating geographical features, particularly the distance between origin and destination zones, to improve predictive accuracy; (3) building ensemble models that compare machine learning and utility function-based approaches, including multinomial logistic regression and nonlinear classification models, achieving over 92% accuracy in mode prediction; and (4) developing a freight

transportation dashboard that visualizes key transportation data, such as commodity flow by origin and destination, transportation mode statistics, and predictions of optimal transportation modes. This dashboard serves as a practical tool for stakeholders to monitor and interpret transportation trends.

Noteworthy, the study addresses the issue of data imbalance, which is common in freight logistics data, by incorporating machine learning techniques to manage skewed distributions across different commodities and transportation choices. These efforts improve the model's ability to predict and interpret freight movement, thereby supporting the planning and operations of multimodal transportation systems aimed at promoting more efficient mobility for goods across the nation.

In parallel to the specific shipper survey-based modeling mentioned earlier, logit models specific based on the CFS data are proposed that are built on the CFS data specific structure. Future shipper behavior study will further examine the causes of errors and propose more realistic methods, such as ones that specifically consider commodity groups and CFS mode consistent, to determine viability of using utility functions for shipper behavior studies so that they may be better integrated into the FAF efforts.

Problem Description

Current freight demand models have significant shortcomings. They are often insensitive to market changes and tend to overlook critical behavioral aspects of the freight decision-making process. Moreover, these models typically fail to consider the complexities of multimodal networks in their structural design. As a result, the logistics decisions and supply chain choices made by firms, the key decision-making units, are not adequately captured.

One of the major objectives of this study is to design a survey that collects data to incorporate both supply chain and logistics components into the freight transportation model. A key focus of this effort is to account for the behavioral aspects of the decision-making process within supply chains. The proposed model operates at a highly disaggregated level, simulating commodity flows between firms. Firms are treated as decision-making units that form trade relationships and supply chains in the freight system, reflecting the behavioral characteristics of decision-makers (firms) within logistics choice models.

A major obstacle in improving these models is the absence of comprehensive, disaggregated microdata. The publicly available data, such as the Freight Analysis Framework (FAF), is largely aggregate in nature, which limits its responsiveness to shifts in logistics practices. FAF, developed through a partnership between the Bureau of Transportation Statistics (BTS) and the Federal Highway Administration (FHWA), provides estimates of U.S. freight flows every five years, covering 42 commodity types across all transportation modes. However, this data is not detailed enough to analyze firm-level freight movements effectively.

To overcome these limitations, one of the primary goals of this study is to develop a survey that will collect detailed, disaggregated data about freight movement in the United States. The survey targets establishments with deep knowledge of shipping flows, aiming to gather data at the level of individual shipments and firms. This approach is expected to improve the accuracy of freight models and provide insights into the decision-making processes behind logistics and supply chain operations.

In addition to designing a comprehensive survey, this study focuses on two other essential improvements: implementing ensemble learning models and addressing data imbalance issues in freight logistics data. A framework of next step Logit models is proposed based on the CFS data structure in order to incorporate the disaggregate shipper data from the survey into building more aggregate models integrated into the FAF structure.

The ensemble learning approach enhances the predictive power and accuracy of freight demand models by integrating multiple machine learning methods. This technique combines results from different model types to produce a more reliable prediction of logistics behaviors, such as mode choice and routing decisions. By comparing and synthesizing outputs from methods like logistic regression and nonlinear classification, the ensemble model overcomes some of the limitations of traditional single-model approaches. This blended approach improves accuracy in capturing the

diverse and complex factors that influence shippers' transportation choices, including variations in commodity types, shipping routes, and logistical constraints.

Another critical challenge in freight logistics data is the issue of data imbalance, where some transportation choices, shipment types, or modes are underrepresented in the data set. Such imbalances can lead to biased predictions, as models may tend to favor more common choices or routes over others that are equally important but less frequent in the data. To address this, the study applies methods to better manage data imbalances, ensuring that less common choices are adequately represented in the model's predictions. Techniques used in this process help the model recognize and weigh all available options more equitably, allowing for a fuller representation of the range of logistics decisions made by firms.

Together, these efforts—designing a detailed survey, leveraging ensemble learning, and managing data imbalances—represent a significant advancement in developing a robust freight demand model. These enhancements not only increase the accuracy of predicting freight flows but also deepen our understanding of the logistical and behavioral dynamics driving transportation choices across various industries. Through this multi-faceted approach, the study ultimately aims to improve the responsiveness of freight demand models to evolving logistics practices and provide valuable insights for stakeholders involved in multimodal transportation planning and policy development.

Approach

The objective of this study is to understand the shippers' behavior in terms of mode choice decisions. A multi-prune approach for this multi-year effort is therefore envisioned to 1) perform a comprehensive survey on shipper decisions, 2) explore machine learning techniques for mode choice decisions, 3) study imbalanced data and effects on choice models, and 4) understand utility functions and their calibration.

Comprehensive data collection is one of the key components of this project. While publicly available data on freight transportation provides a good starting point for modeling, it is often aggregated, which makes it difficult to accurately model shipper behavior at a disaggregated level. Therefore, this project aims to collect detailed data through a carefully designed survey.

There are three major types of freight surveys: roadside surveys, vehicle owner surveys, and establishment surveys. Each type of survey has its own advantages and disadvantages and is conducted to achieve specific goals. This study focused on establishment surveys, which are easier to access and provide more detailed information. Individuals responsible for making shipment movement decisions within companies were asked to complete the survey to collect accurate and comprehensive data.

To distribute the online survey, contact details for logistics and shipping managers of businesses were purchased. To increase response rates, participants were contacted by phone before the email invitations were sent. During these calls, the significance of the survey was emphasized, and participants were encouraged to take part. Additionally, incentives were offered to further promote engagement.

Among the various survey methods, web-based surveys were chosen for this study, as they are a common and efficient way to collect freight transportation data. Telephone surveys, while an option, require shorter questionnaires due to the participants' time constraints, which limits the amount of data that can be gathered. Personal interviews, though useful, are more appropriate for local surveys and smaller populations, rather than nationwide studies.

Researchers had access to a wide range of web-based survey tools, many of which are free to use. However, free tools often limit the number of active surveys or responses and offer only basic question formats. While basic surveys might suffice for gathering general feedback, this study required a more flexible tool for running fully web-based stated choice experiments. For instance, incorporating online services into the survey proved to be a practical solution. Custom JavaScript code was added to the survey platform, such as in Qualtrics, to extract external data, including choice designs.

The questionnaire was designed using Qualtrics, a powerful platform for designing surveys and collecting data. In addition to the numerous built-in options offered by the platform, custom JavaScript code was incorporated to enhance the survey's capabilities. One key modification was the integration of the Google Maps API to allow respondents to specify the origin, destination, or stop

location of shipments directly through the survey interface. This feature greatly streamlined the data collection process by providing precise geographic data.

A well-designed survey limits free-text responses as much as possible to minimize variability in the data. Allowing respondents to enter arbitrary options or values can make the data unreliable. To address this, the survey was designed to present respondents with a range of predefined choices, including options for selecting the unit of measurement. The number of options was carefully balanced—not too many to overwhelm respondents, but sufficient to ensure accuracy.

For questions requiring continuous values, respondents could manually input their data. However, a validation process was implemented to ensure the accuracy of the numerical values provided. Additionally, the survey was designed to allow respondents to select the appropriate metric of measurement, ensuring data consistency across responses.

In addition to survey efforts, this study employs ensemble learning methods to classify freight mode patterns and enhance predictive accuracy in modeling shippers' mode choices. Recognizing that mode choices are influenced by a range of factors such as commodity type and industry classification, we employed various machine learning models—including logistic regression, decision trees, random forests, and XGBoost—to predict transportation mode preferences across different categories. By combining these models in an ensemble framework, we were able to improve prediction accuracy and capture the diverse influences on mode choice decisions.

To further enrich our analysis, utility-based models were also developed. Both linear and non-linear utility functions were used to examine the factors underlying mode selection, with Multinomial Logit Models (MNL) applied to estimate the probability of selecting each transportation mode. This approach allowed us to compare the predictive performance of each model type using an evaluation matrix, enabling a comprehensive assessment of which models were most effective in representing mode choice behavior. The ensemble learning framework thus provided a more reliable prediction of logistics choices, supporting a nuanced understanding of decision-making across varying commodity types and industry classifications.

A significant challenge in modeling shippers' choices is the issue of data imbalance. In freight datasets, certain transportation modes and options are often underrepresented, which can bias predictions by favoring the more frequent choices. To address this imbalance, we employed resampling techniques to adjust the distribution of categories within the dataset, ensuring a more balanced representation. Additionally, Monte Carlo simulations were applied to generate synthetic data points that could enhance the underrepresented categories, improving the model's ability to recognize less common but important choices.

In evaluating model performance, standard accuracy metrics were supplemented with additional evaluation measures specifically chosen to reflect the impacts of data imbalance. For instance, metrics such as F1 score and area under the receiver operating characteristic (ROC-AUC) curve were used to assess model performance across both dominant and less frequent categories. This

multi-metric approach provided a more balanced and accurate picture of the model's effectiveness in predicting mode choices across all transportation options.

By integrating efforts in data collection, ensemble learning, and data balancing, this study advances the modeling of freight demand with greater predictive accuracy and robustness. The combination of a detailed survey, ensemble model framework, and techniques to mitigate data imbalance contributes to a comprehensive understanding of shippers' mode choice behaviors, offering valuable insights for planners and policymakers working to improve multimodal transportation networks.

Methodology

For the first installment of this multi-year study, the main efforts focused on designing a comprehensive survey for shipper behaviors, exploring machine-learning approaches for shipper behavior model, and understanding of the imbalanced data in shipper behaviors.

Comprehensive Survey

The questionnaire is divided into two primary sections. The first section focuses on collecting data about the attributes of each business establishment, including its location, employee size, the total annual value of shipments, the number of weekly inbound and outbound shipments, and information about major suppliers. This section provides essential background details about the companies participating in the survey.

The second section gathers detailed information on the last three shipments made by each business. This includes the point of origin, destination, mode of transportation, type of commodity, value, weight, and other shipment-specific details. Additionally, questions are asked about the number of stops along the route, the transportation mode used to reach each stop, as well as the time and cost associated with accessing each stop. This level of detailed data is crucial for developing an accurate representation of supply chains.

This comprehensive data collection is necessary to create disaggregated logistics choice models, which require extensive information on the characteristics of individual shipments and the decision-making processes of firms. These models help to establish which shipments move through ports, airports, consolidation centers, distribution centers, and intermodal terminals, and which shipments use direct transportation. Furthermore, the data specifies the modes and types of vehicles used in the transportation chains, ensuring that the model can accurately reflect real-world logistics operations.

Details of the comprehensive survey are shown in the Appendix section of this report.

Ensemble Learning

In collaboration with our Oak Ridge National Laboratory colleagues (ORNL), Commodity Flow Survey (CFS) Public Use File (PUF) data from 2017 were used for shipper behavior study. Ensemble learning techniques were employed to determine the best combinations of models for each separate commodity/industry category. At the same time, we compare the results of most types of machine learning model and utility function model.

Machine Learning Model

(1) Building Base Learners (Level -1 Models)

Various machine learning models, referred to as base learners, are trained on the input features. These models include logistic regression, decision trees, random forests, support vector machines, and others. Development of local models tailored to different commodities and industry types, allowing the models to exploit the heterogeneity of the data.

(2) Ensemble Learning with Level - 2 Models

After training individual base learners, the study moves to combine these models using ensemble learning techniques like voting and stacking. A meta-learner (level - 2 model) aggregates the predictions of the base learners to form the final prediction using machine learning techniques, which is efficient for large-scale datasets.

Utility Function Models

(1) Linear Regression Function

The form of utility assumes a linear relationship between each feature and the utility gained from selecting a specific transportation mode.

(2) Non-linear Utility Function

The Cobb-Douglas utility function introduces different elasticities of substitution between variables and interaction effects between variables. This model better captures the non-linear interactions between variables. It allows for correlated decision alternatives and is particularly useful when modes can be grouped into categories

(3) Model Calibration and Probability Calculation of Final Mode Choice

The parameters of the utility functions are calibrated using Maximum Likelihood Estimation (MLE). Multinomial Logit Model (MNL) is used to model the probability of a shipper selecting a particular transportation mode. When we obtain the utility value of each type of SCTG under different transportation modes, the probabilities of choosing each transportation mode are computed for different commodity types (SCTG categories) and origin-destination pairs, according to the principle of discrete model.

Data Imbalance

Data imbalance presents a significant methodological challenge in accurately modeling shippers' mode choice behavior. In freight transportation datasets, such as those from the Commodity Flow Survey (CFS), certain transportation modes or choices are often underrepresented. For instance, while trucking and rail may appear frequently due to their widespread use, other modes like air or maritime transport might be far less common, creating an imbalance. This skew can lead to biased models, as standard machine learning algorithms tend to focus on predicting the more frequent choices at the expense of rarer but relevant options. Addressing this imbalance is crucial for developing a model that reliably captures the full spectrum of shippers' logistics decisions.

To mitigate the effects of data imbalance, resampling techniques were employed as a primary strategy. Oversampling was used to increase the representation of underrepresented categories, ensuring that the model received adequate training data for these choices. Similarly, undersampling reduced the frequency of dominant classes to prevent the model from overly favoring these choices. By balancing the dataset, resampling allowed the model to learn the decision patterns for less common transportation modes, helping to produce a more comprehensive predictive model.

Monte Carlo simulations were also utilized as an advanced approach to tackle data imbalance. This method involved generating synthetic data points that mirror the characteristics of underrepresented categories, effectively increasing their sample size within the dataset. Monte Carlo simulation created a controlled way to simulate possible outcomes for less frequent modes, allowing the model to better generalize across all transportation modes. This approach enabled the

model to recognize patterns in the decision-making processes for all choices, reducing bias and improving prediction accuracy.

In evaluating the model's performance, traditional accuracy metrics were not sufficient on their own, as they can mask the effects of data imbalance by focusing only on the model's success with more frequent categories. Therefore, additional metrics—such as the F1 score, which balances precision and recall, and the area under the receiver operating characteristic (ROC-AUC) curve—were applied to gauge the model's ability to correctly classify both frequent and infrequent categories. These metrics provided a more nuanced understanding of the model's performance, ensuring that it was effectively capturing the complexity of shippers' mode choices across the full range of transportation options.

Together, these data balancing methods contributed to a more robust and equitable model that reflects the diversity of decisions made by shippers. By carefully addressing data imbalance, this study ensures that the final model offers a realistic and useful tool for stakeholders, providing insights into both common and less frequent logistics choices in freight transportation. This balanced approach is essential for creating predictive models that are responsive to the complexities and variability inherent in real-world transportation systems.

Findings

Data documentation

1. 2017 Commodity Flow Survey's Public Use File (2017 CFS PUF)
The data set used is public available at:
https://www.census.gov/data/datasets/2017/econ/cfs/historical-datasets.html
This dataset contains detailed information on U.S. freight shipments, including variables such as shipment mode, weight and value of the shipment, SCTG, NAICS and origin, destination, distance, routed distance and so on. It is publicly available and provides a comprehensive view of freight flows across different transportation modes. The CFS data are used by policy makers and transportation planners in various federal, state, and local agencies for assessing the demand for transportation facilities and services, energy use, and safety risk and environmental concerns.

Table 1. Description of information from the CFS PUF data set

Name		Description	Column Example
Basic info.	Mode (target variable)	Shipment mode	-
	Weight	Weight of the shipment (in US pounds)	-
	Value	Value of the shipment (in US dollars)	-
	SCTG	Two-digit SCTG commodity code of the shipment (43 categories)	-
	NAICS	Industry classification of the shipper (45 categories)	-
Spatial info.	Origin	Origin code (state code and metropolitan area code)	orig_state, orig_state_full, states_code_o, orig_ma, orig_cfs_area
	Destination	Destination code (state code and metropolitan area code)	dest_state, dest_state_full, states_code_d, dest_ma, dest_cfs_area
	Distance	Great circle distance between origin and destination (in miles)	-
	Routed distance	For the chosen mode, the actual routed traveling distance of the shipment (in miles)	-
Supplemental info.	HAZMAT	Hazardous material (Class 3.0 hazard, other hazard, or not hazard)	-
	Temperature controlled	Temperature-controlled shipment	-

2. Collected survey results.

Analyses performed

1. **Data Preprocessing**

First, the raw data is carefully preprocessed to ensure uniformity and accuracy by removing missing or erroneous entries. Categorical variables, such as shipment mode and commodity type, are encoded to make them suitable for analysis in machine learning models. Additionally, numerical features like distance and weight are standardized, enhancing the performance and stability of model training.

Second, to address the challenge of data imbalance, where certain transportation modes are underrepresented, resampling techniques such as the Synthetic Minority Oversampling Technique (SMOTE) are applied. This process helps balance the dataset, reducing the risk of biased predictions that might otherwise favor the more frequently chosen modes.

Third, the dataset is divided into training and test sets, with 80% allocated to training and 20% reserved for testing, using stratified random sampling. This approach ensures that the training and test sets are proportionally representative of various commodity types (SCTG codes) and industry categories (NAICS codes). Finally, geographical features are extracted from the dataset to develop a detailed profile of freight movements between metropolitan areas, providing crucial spatial context to the analysis.

2. Exploratory data analysis

The 2017 Commodity Flow Survey (CFS) dataset provides data in three main categories. First, Basic Information includes shipment mode (e.g., for-hire truck, rail, air), shipment weight, value of goods, and classifications for both commodity type (SCTG codes) and industry (NAICS codes). Second, Spatial Information covers the origin and destination of shipments, as well as both great-circle and routed distances. Finally, Supplemental Information includes details such as whether a shipment contains hazardous materials or requires temperature control. Extended research efforts focus on leveraging ensemble models and addressing data imbalance using these diverse variables.

2.1 Mode Classification

To enhance the analysis of mode choice, we classified transport modes into seven distinct categories, allowing for a better alignment of data variables with each mode and enabling closer observation of how specific variables influence mode selection outcomes. Incorporating routed distance directly as a model input, however, could lead to a loss of nuanced information and increase the risks of model bias and overfitting. To address this, we extracted and analyzed geographic information patterns on a state-by-state basis, which provided a more detailed spatial understanding of transportation modes across regions.
Fig. 1 shows the share of different modes with respect to shipments weight, shipments value routed distance and total weight, total value, total ton-miles traveled.

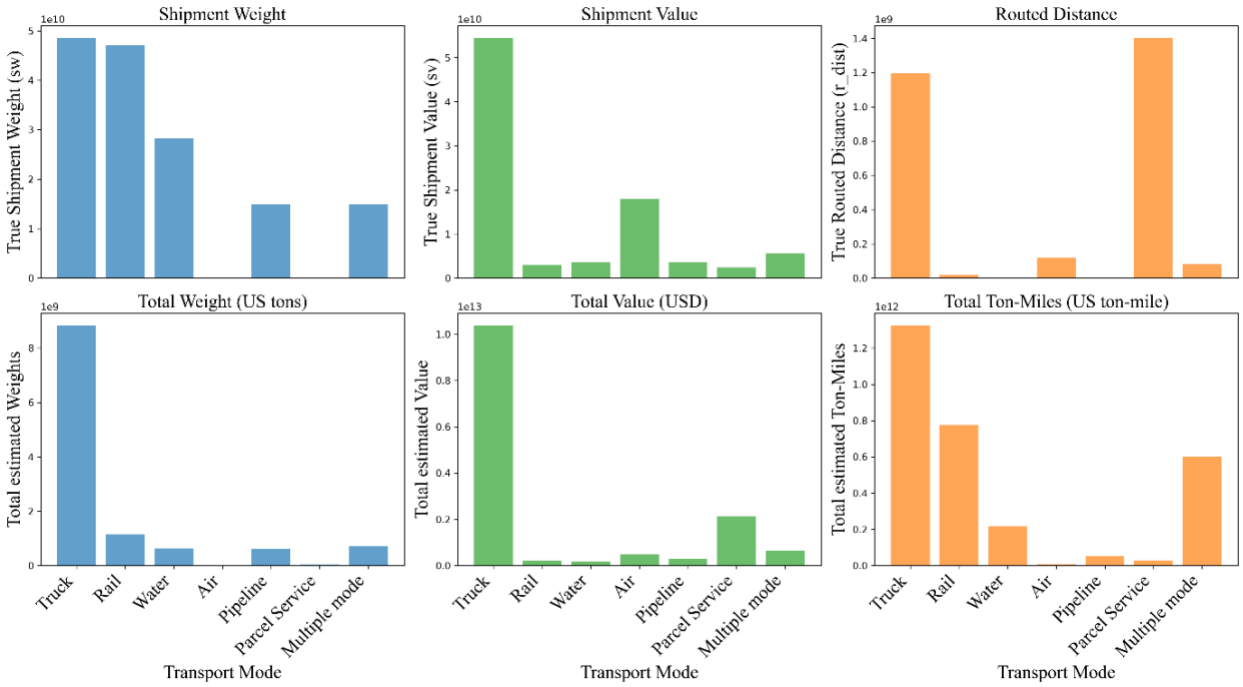

Fig. 1. Share of different modes with respect to shipments weight, shipments value routed distance and total weight, total value, total ton-miles traveled.

2.2 Analyzing Freight Mode Choice

For a deeper analysis of mode choice, routed distance estimates were derived for each shipment's origin and destination, including distances for both selected and non-selected modes. This approach allowed us to create a geographic profile that maps various freight modes across states and metropolitan areas. These derived distances, available for all transportation modes, were included as model inputs to enrich the analysis. Fig. 2 displays the value share of different freight modes by origin state.

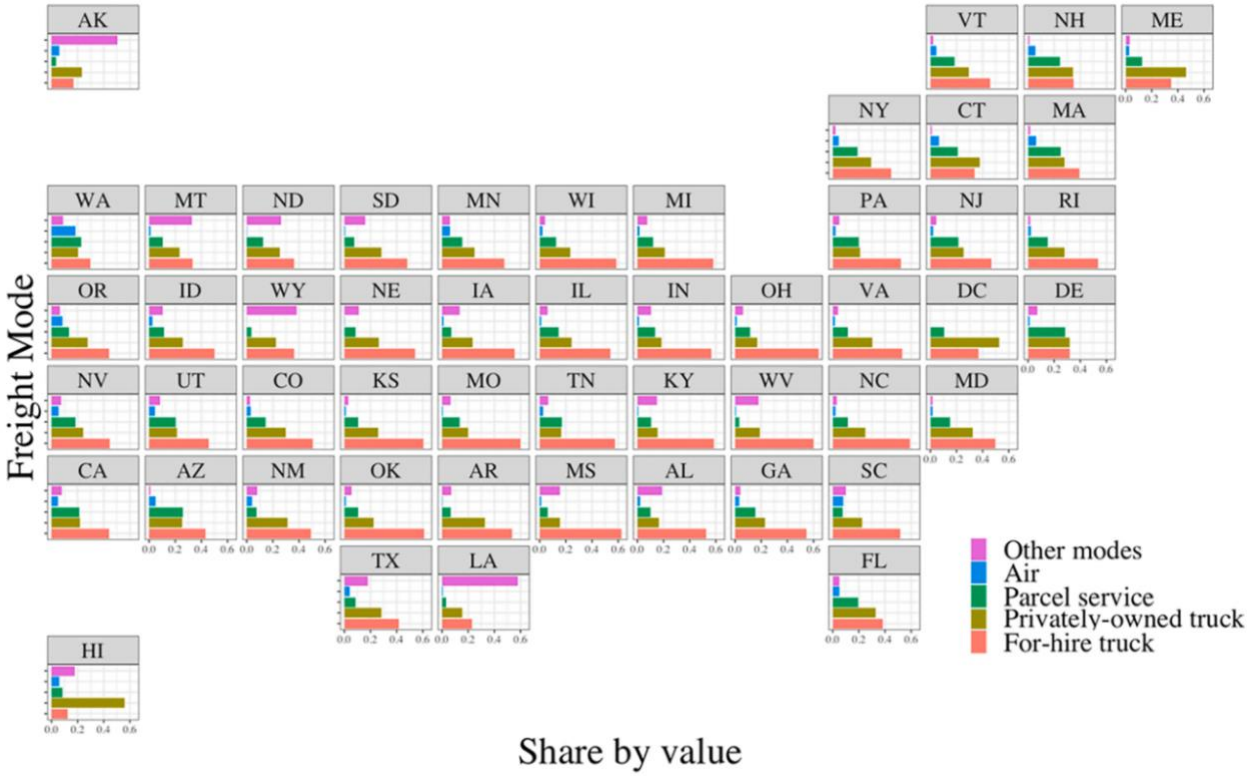

Fig. 2. Percentage value share (in US dollars) of different freight modes by origin state.

Extreme Gradient Boosting (XGBoost) was employed to construct a regression model that identifies and prioritizes the variables most strongly influencing mode selection. This model ranks the importance of each feature in predicting transportation mode. To optimize feature selection, an XGBoost model was applied to each SCTG category to rank variables by their predictive significance. The final selected features informed the construction of utility selection models tailored to each SCTG category, enhancing the model's relevance and precision in capturing shippers' decision-making patterns. Fig. 3 presents the feature importance score for each SCTG category derived using machine learning methods to assess the relationships between variables and calculate the.

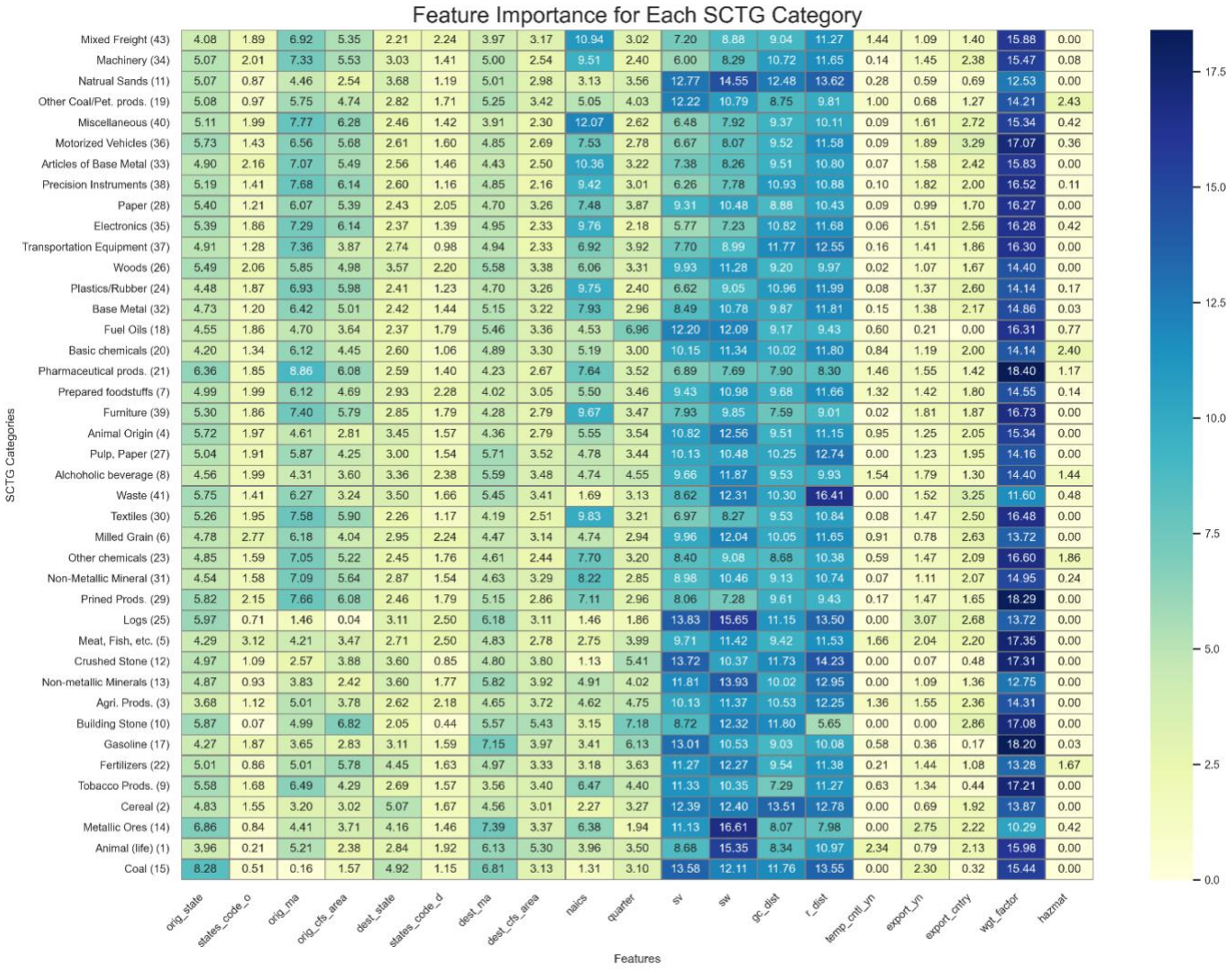

Fig. 3. Feature Importance Score for each SCTG category

3. Machine learning and utility function modeling

- Level – 1 base models: logistic regression, decision tree, random forests, support vector machines
- Level – 2: combine level -1 models using ensemble learning techniques such as voting or stacking.
- Linear and nonlinear utility function models
- Multinomial logit model

Fig. 4 shows the mode choice Probability for Linear Utility Function and Nonlinear Utility Function of each SCTG type.

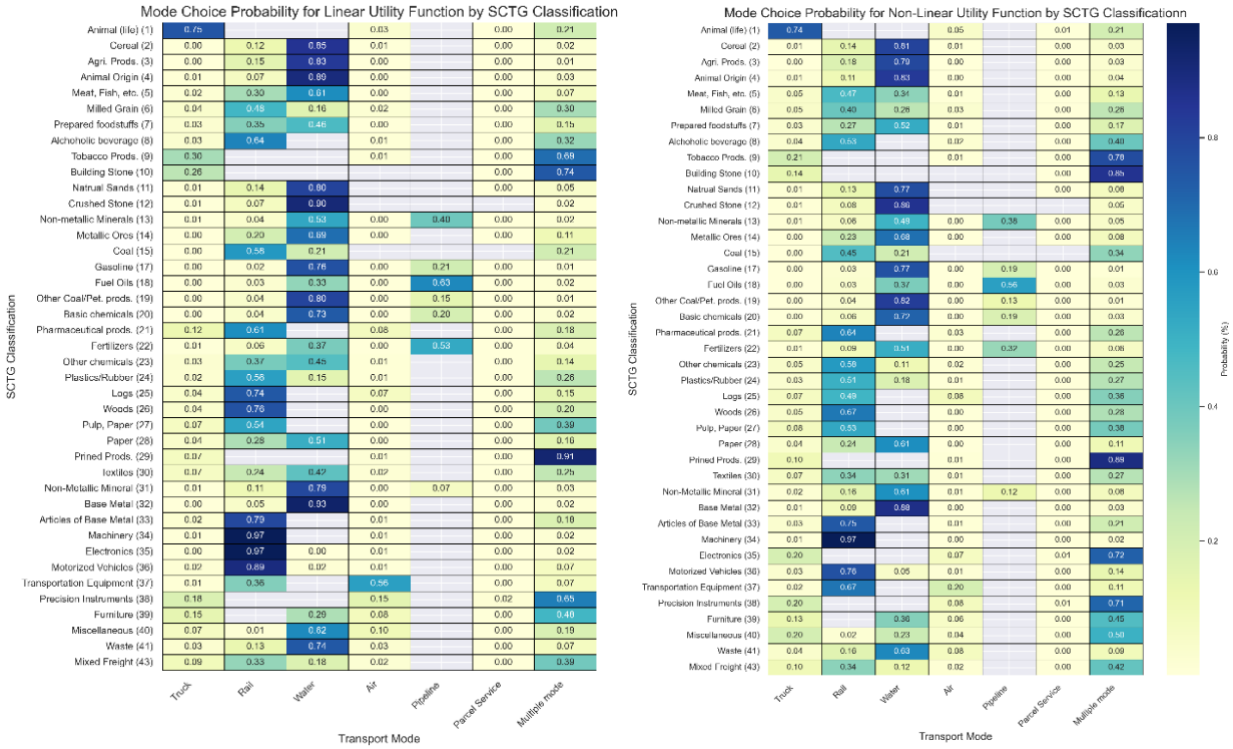

Fig. 4. Mode Choice Probability for Linear Utility Function (the left column) and Nonlinear Utility Function (the right column) of each SCTG type

Results

1. Experiment Results and Comparison

After developing the machine learning and utility function models, we applied them to analyze shipments between each origin and destination state and assessed the performance for each transportation mode and SCTG type. Model effectiveness was evaluated using key performance metrics: accuracy, precision, recall, and F1 score. The following section provides a detailed overview of the experiment results, illustrating how each model performed across these evaluation criteria.

1.1 Model Performance

Based on the machine learning model analysis, the stacking model was selected as the final model and the accuracy of the final model was illustrated below.

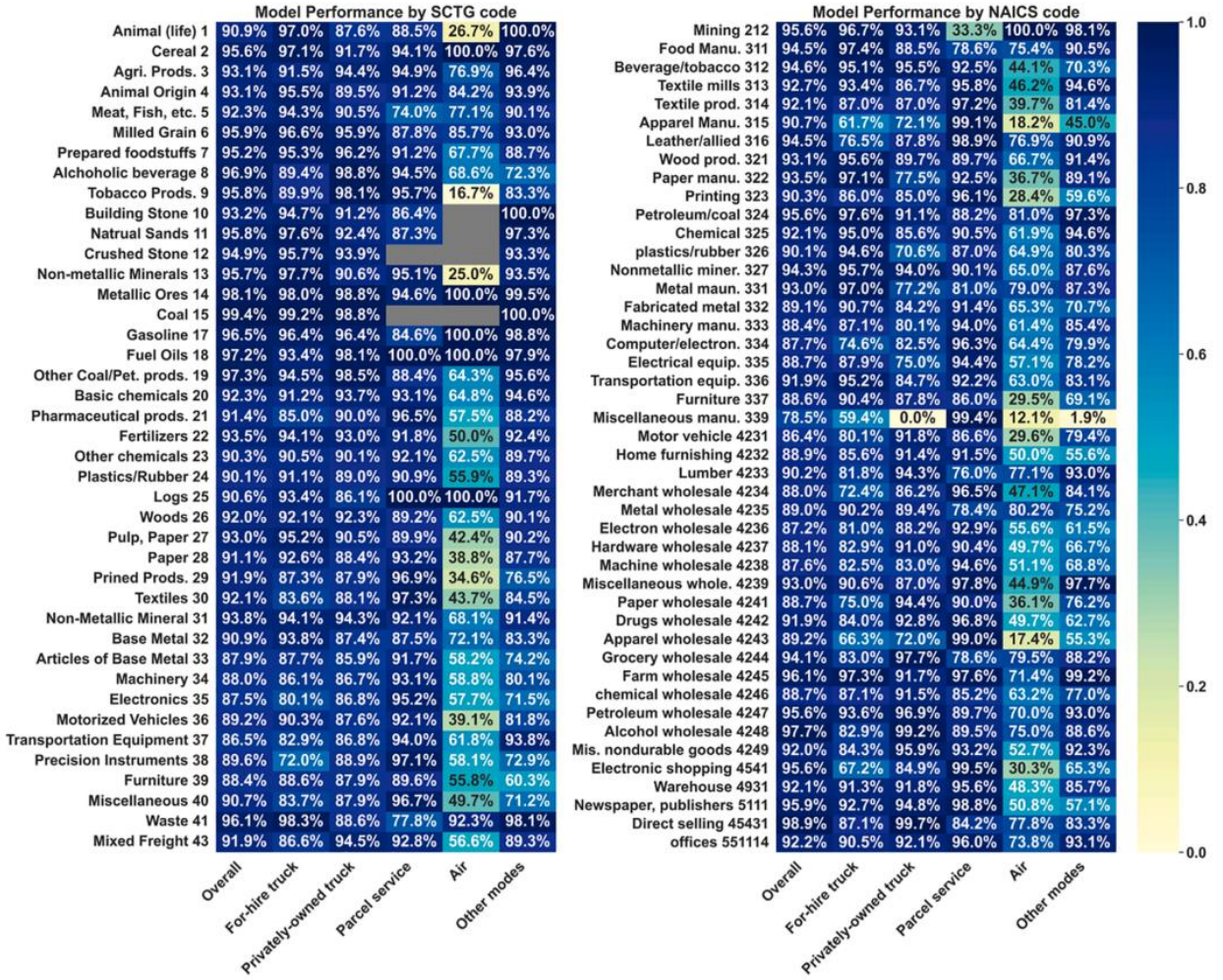

Fig. 5. Accuracy of the final model for each freight mode by SCTG code (the left column) and by NAICS code (the right column)

To evaluate MNL model results, metrics such as McFadden's R-squared and F-1 score are used to estimating the goodness of fit between models.

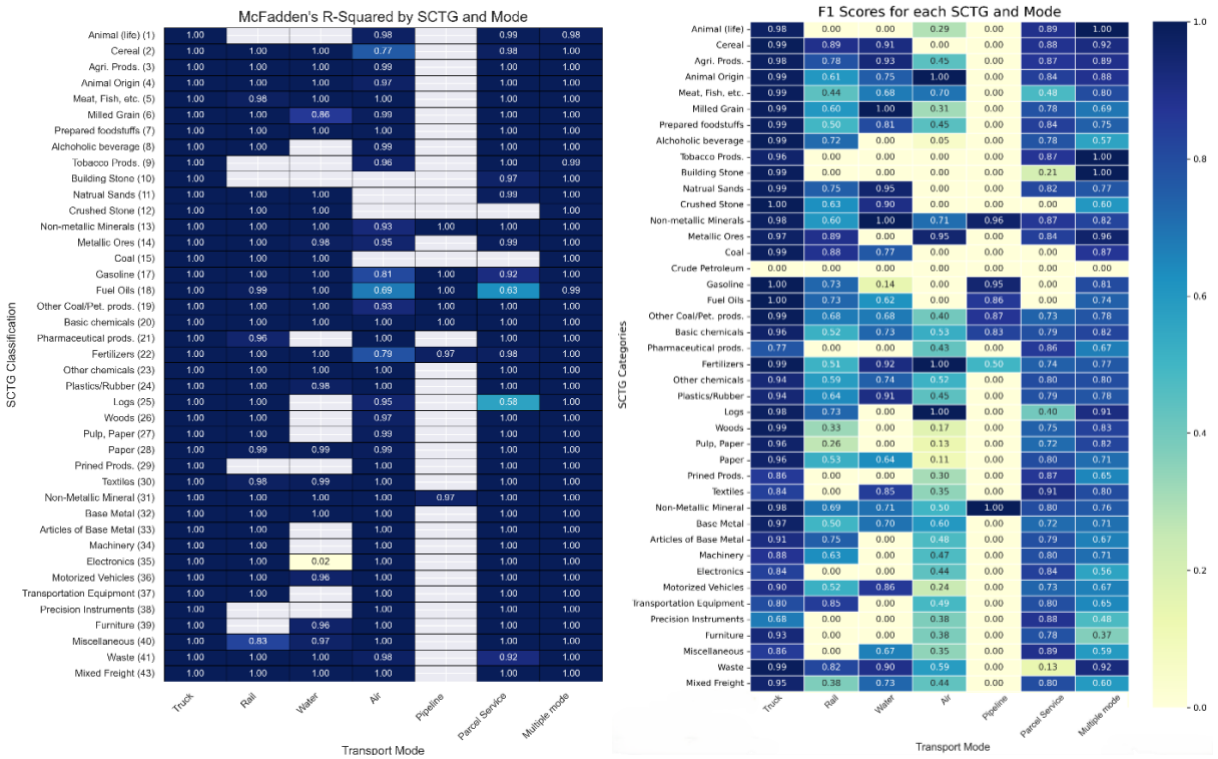

Fig. 6. McFadden's R-squared (the left column) and F-1 score (the right column) of MNL model for each freight mode by SCTG code

1.2 Results Comparison

The performance of linear and nonlinear models with derived distance features is better than the performance of voting and stacking models without derived distance features. However, the performance of voting and stacking models with derived distance features is superior to the performance of linear and nonlinear models with derived distance features.

In other words, incorporating derived distance information into the models improves their overall performance. The voting and stacking techniques, which combine multiple models, achieve the best results when the derived distance features are used, outperforming the linear and nonlinear models even when they also have access to the derived distance information. Table 2 displays the performance for different models.

Table 2. The performance of overall evaluation metrics of the utility functions and machine learning models

Parameter	**Value**					
	Linear Utility With derived distance	**Nonlinear Utility** With derived distance	**Vote** Without derived distance	**Vote** With derived distance	**Stack** Without derived distance	**Stack** With derived distance
Accuracy	0.9037	0.9159	0.851	0.923	0.862	0.928
Precision	0.9042	0.9174	0.854	0.924	0.861	0.928

Recall	0.9037	0.9159	0.851	0.923	0.862	0.928
F1 Score	0.9022	0.9158	0.849	0.922	0.861	0.927

The key advantages of machine learning ensemble models, such as voting and stacking, are:

- **High Predictive Power**: By combining multiple models, these ensemble methods often achieve high accuracy and can handle complex, nonlinear relationships within the data.
- **Robustness**: These models are generally resilient against overfitting, especially when working with larger datasets, as they balance the predictions of multiple individual models.

On the other hand, the main drawbacks of machine learning ensemble models are:

- **Interpretability**: Ensemble models often operate as "black-box" approaches, making them difficult to interpret. While feature importance can provide some insights, the overall decision-making process behind these models is inherently complex.
- **Parameter Tuning**: Ensemble methods require extensive hyperparameter tuning, which can be time-consuming and necessitate advanced expertise to optimize the results.

The key advantages of utility-based models are:

1. **Adaptability**: Utility-based models, such as those using XGBoost for feature selection, can adapt to various data types and problem structures.
2. **Interpretability**: Utility models are inherently interpretable, providing clear insights into the importance of different attributes for decision-making. This clarity is valuable for stakeholders who need to understand and explain the results.
3. **Theoretical Foundation**: Utility models are grounded in economic theory, making them suitable for scenarios that require adherence to rational choice or decision-making frameworks.

However, the main drawbacks of utility-based models are:

- **Data Assumptions**: Utility models often assume a level of linearity and independence among variables, which may not always hold true in real-world data.
- **Sensitivity to Specification**: Utility models can be sensitive to how the features and utilities are specified; incorrect specification can lead to poor model performance.

Machine learning ensemble models, such as voting and stacking, are advantageous when the primary goal is to achieve high predictive accuracy, especially in contexts with complex, nonlinear data relationships. These models excel at handling intricate patterns within the data and often outperform individual models in terms of overall accuracy.

On the other hand, utility-based models are more suitable for applications that prioritize interpretability and alignment with theoretical decision-making frameworks. These models provide clear insights into the importance of different attributes for the decision-making process, making them a good choice for domains like economics, transportation planning, or policy research, where understanding the rationale behind the decisions is as crucial as the predictions themselves.

In cases where practitioners need to balance both predictive power and interpretability, a combination of machine learning ensemble models and utility-based approaches could be considered. By integrating the strengths of these two model types, future work could explore the development of hybrid models that leverage the benefits of both approaches.

2. Data Imbalance

The distribution of data across different transportation modes varies significantly, with air transport representing only 2% of the total data, leading to a substantial issue of data imbalance. Fig.7. illustrates that adjustments to the proportion of various air modes result in notable changes in both global accuracy and the R-squared values for the overall model and the truck transportation mode.

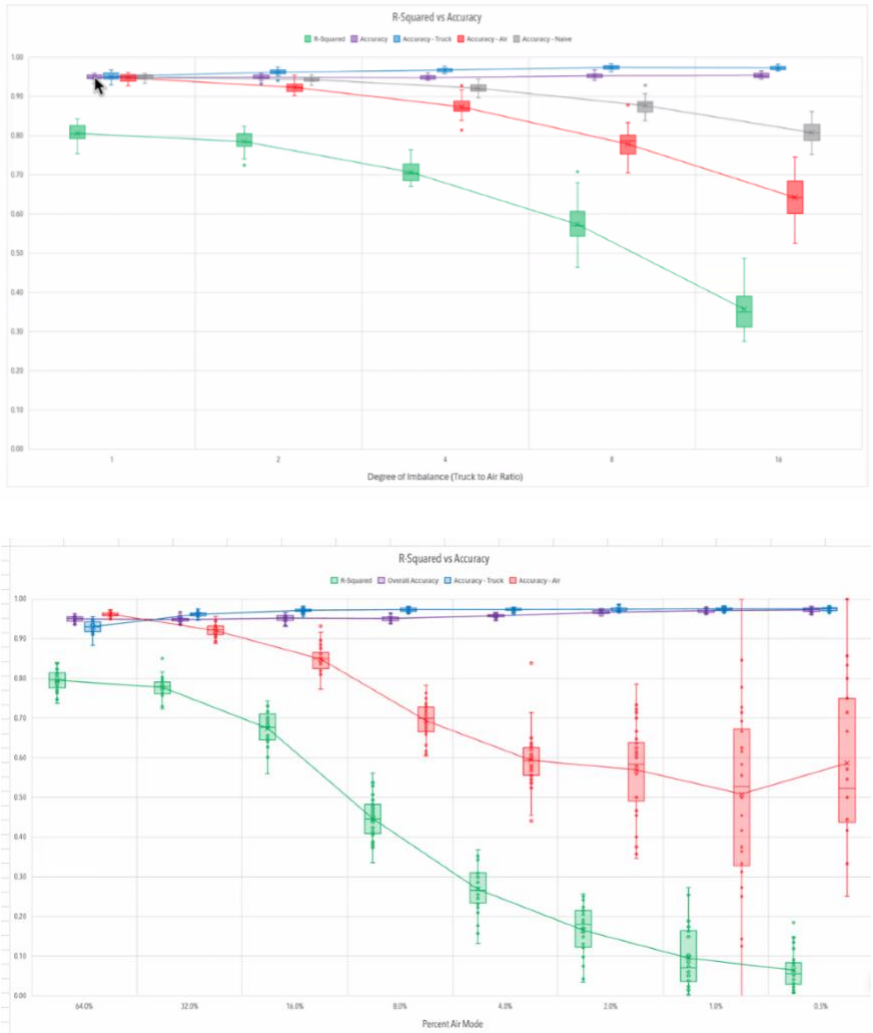

Fig. 7. The influence of accuracy and R squared by different air modes percent

3. Mode and SCTG Compatible Logit Model Framework for Next Steps

In order to overcome the many issues with data such as the above-mentioned imbalance and oftentimes data scarcity in some markets of CFS dataset, the team has proposed a framework of Logit oriented utility function that is expected to be mode and SCTG category compatible so that it may be used in the CFS datasets for calibration and application. The specific utility function

proposed here is $V_m^i = \beta_m \delta_m^i + \beta_c \delta_c^i + \beta_2 w^i + \beta_3 v^i + \beta_4 d^i$s, where V_m^i is the measurable utility for individual shipper *i* choosing mode *m*. **β** are the parameters to calibrate and δ_m^i is a binary indicator, which is 1.0 when individual shipper (or shipment) *i* chooses mode *m*. m is a specific mode in a complete set of 16 in the CFS dataset including trucking for hire, rail-truck, etc. δ_c^i is a SCTG commodity group specific indicator; it is 1.0 when a specific SCTG group *c* is concerned for individual shipper (or shipment) *i*. β_c is a coefficient unique to the commodity group *c*. Here *C* represents the set of all commodity groups of 43, including bulk, electronics, etc., $c \in C$.

The proposed framework of utility function tailored specifically for the CFS data structure would allow use of the CFS data directly for general calibration of the Logit models across markets, modes and commodity groups to overcome the imbalance and data scarcity issues.

4. Data Visualization

What's more, we also made some result for data display, which called the '2017 Commodity Flow Survey (CFS) Public Use File (PUF)'s dashboard. This freight commodity flow survey dashboard for shipper behavior study using the Streamlit platform. It shows the basic information of freight transportation under specific OD and specific SCTG, NAISC categories based on the original 2017 CFS dataset, and shows the distribution of different mode choices. There is the link for the dashboard. https://cfs-freight-explorer.streamlit.app/

Fig. 8. 2017 Commodity Flow Survey (CFS) Public Use File (PUF)'s dashboard

Technical Transfer and Commercialization

Presentations & Publications

1. A poster outlining the desired framework was presented at the annual FRSC conference at the University of Tennessee. However, since the target number of responses has not yet been collected, other publications have not been completed.

Community Engagement

None

Other relevant efforts

After the questionnaire was finalized, Institutional Review Board (IRB) approval from the University of Illinois was required before the survey could be launched. The approval process began on April 16, 2024, and final approval was granted on July 2, 2024. Since this is a behavioral study, the IRB team reviewed the protocol multiple times, requesting several modifications to clarify what information would be gathered in the survey. A snapshot of the protocol form needed to be completed is in the screenshot below.

WHY IS THIS STUDY BEING DONE?	We want to gather data about factors affecting utility function of shippers in the US.
WHAT WILL I BE ASKED TO DO DURING THE STUDY?	If you are a logistics manager involved in making logistical decisions, you will be asked to complete an online questionnaire about the establishment you work for and three recent shipments of which you are aware, including details such as origin, destination, shipping time, and cost.
HOW MUCH TIME WILL I SPEND ON THE STUDY?	The total estimated time to complete the survey is approximately 18 minutes for logistics managers and approximately For more information, please see the "What Procedures are Involved?" section below.
ARE THERE ANY BENEFITS TO TAKING PART IN THE STUDY?	Participating in this research study may not benefit the participants in the short run; however, they could benefit from the outcomes of the survey in the long run. Additionally, their responses will help researchers to have better knowledge about shipment movement and shippers behavior
DO I HAVE OTHER OPTIONS BESIDES TAKING PART IN THE STUDY?	You have the option to decide not to take part at all or you may stop your participation at any time without any consequences.
QUESTIONS ABOUT THE STUDY?	For questions, concerns, or complaints about the study, please contact the researcher student Zahra Hajibagher at zhajib2@uic.edu under supervision of Prof. Abolfazl Mohammadian at kouros@uic.edu If you have questions about your rights as a study subject; including questions, concerns, complaints, or if you feel you have not been treated according to the description in this form; or to offer input you may call the UIC Office for the Protection of Research Subjects (OPRS) at 312-996-1711 or 1-866-789-6215 (toll-free) or e-mail OPRS at uicirb@uic.edu.

Meanwhile, the research team purchased contact lists of logistics and shipper managers from various companies to distribute the survey. Once IRB approval was received, emails inviting participants to complete the survey were sent through the Qualtrics platform. Unfortunately, the response rate was lower than expected, with only eight completed responses.

To boost the response rate, two follow-up reminders were sent to those who had not yet completed the survey. Additionally, an intern called some of the individuals on the contact list to explain the purpose of the survey and encourage participation. While many declined to participate, some individuals expressed interest. The email addresses of those who showed interest were stored separately, and a unique survey link was sent to them to monitor their responses more effectively. Despite these efforts, many still did not complete the survey, even though gift cards were offered as incentives. Furthermore, many recipients did not open the survey link at all.

The purchased contact list included 5,881 logistics managers and 2,119 shipper managers. To gather more comprehensive data about shipment movements, an additional contact list of 2,000 truck drivers was also purchased, providing further insights into shipments.

Other data collection methods were considered to gather more reliable responses. One alternative was to advertise the survey link on social media platforms, particularly LinkedIn, to target the relevant audience. However, LinkedIn does not offer specific job title targeting options for survey advertisements. Attempts were made to connect with people holding relevant job titles, but many did not open the survey link.

Some data companies providing updated contact information showed biases, affecting the reliability of the data. As a result, the research team began exploring the option of using online survey platforms that have access to large panels of respondents, which could potentially increase response rates. These platforms typically define the target population and provide a specific number of completed responses based on the study's requirements. Currently, UIC is working on finalizing a contract with QuestionPro, an online survey platform, to secure the remaining completed responses.

In summary, additional time is required to gather sufficient data for a thorough analysis. Once the necessary data has been collected, a more robust model and framework for understanding freight movements and shipper behaviors can be developed. This will provide valuable insights into logistics decisions, such as mode choice and multimodality.

Conclusions

Disaggregate logistics choice models need thorough and in-depth information on individual shipments as well as the actions of decision-makers. To collect disaggregated data on freight movement, a comprehensive survey was designed as part of this study to address the shortcomings of the current freight demand models. The study is to improve the precision of freight demand forecasts and get a deeper understanding of the complexities of freight transportation networks by concentrating on the logistics decisions and processes for making choices of freight transportation systems.

The key contributions in addition to designing the survey are:

(1) Constructing local models for each separate commodity/industry category to better capture the unique characteristics and preferences within different freight sectors.

(2) Extracting useful geographical features, particularly the derived distance of each freight mode between origin and destination zones, to enrich the model inputs.

(3) Building and comparing the performance of machine learning ensemble models (e.g., voting, stacking) and utility function models (e.g., multinomial logistic regression, nonlinear classification) to leverage the strengths of different modeling approaches for improved overall accuracy. The proposed method achieved over 92% accuracy without incorporating external information.

(4) Establishing a freight transportation dashboard to conveniently display basic transportation data, including types of transported goods, transportation mode statistics, and prediction results of the best transportation mode. This framework could enhance the performance and interpretability of existing freight mode choice models.

(5) Addressing the potential imbalance in the data by employing techniques such as oversampling, undersampling, or class-weighted loss functions to ensure the models are trained effectively on all freight mode choices, even those with less represented data.

Our comprehensive approaches leverage both data-driven and theory-based modeling techniques, while also considering the practical needs of freight transportation stakeholders through the development of the interactive dashboard.

Key advancements in this study include four main areas of improvement: (1) constructing localized models specific to each commodity or industry category to capture unique characteristics; (2) incorporating geographical features, particularly the distance between origin and destination zones, to improve predictive accuracy; (3) building ensemble models that compare machine learning and utility function-based approaches, including multinomial logistic regression and nonlinear classification models, achieving over 92% accuracy in mode prediction; and (4) developing a freight transportation dashboard that visualizes key transportation data, such as commodity flow by origin and destination, transportation mode statistics, and predictions of optimal transportation modes. This dashboard serves as a practical tool for stakeholders to monitor and interpret transportation trends.

Noteworthy, the study addresses the issue of data imbalance, which is common in freight logistics data, by incorporating machine learning techniques to manage skewed distributions across different commodities and transportation choices. These efforts improve the model's ability to predict and interpret freight movement, thereby supporting the planning and operations of multimodal transportation systems aimed at promoting more efficient mobility for goods across the nation.

In parallel to the specific shipper survey-based modeling mentioned earlier, logit models specific based on the CFS data are proposed that are built on the CFS data specific structure. Future shipper behavior study will further examine the causes of errors and propose more realistic methods, such as ones that specifically consider commodity groups and CFS mode consistent, to determine viability of using utility functions for shipper behavior studies so that they may be better integrated into the FAF efforts.

Recommendations

The questionnaire is attached as a separate file to this report.

Appendix. Comprehensive Questionnaire

The questionnaire is attached as a separate file to this report.

Consent form:

Dear Logistics Managers and Supply Chain Professionals,

The transportation of goods is a critical component of our national economy, but current freight demand models often overlook the nuances of logistics behavior at the decision-making level. The University of Illinois at Chicago (UIC) is conducting a study titled "Freight Movement and Agent-based Modeling." This research is dedicated to understanding the decision-making processes in logistics and supply chain management within companies. We are keen to explore how firms like yours make transportation decisions, manage shipments, and so on. Your insights will contribute to the enhancement of our framework, an advanced tool for simulating goods transportation, focusing on company behaviors and decision-making intricacies.

Participating in this study is voluntary. As a token of gratitude, the respondents who complete the survey will have an opportunity to win one of twenty **$100 gift cards**. With an anticipated 200 responses, this implies that each respondent stands a 10% chance of winning a gift card. The gift cards will be sent via email after the completion of the survey. This survey will take about 18 minutes to complete. Once the survey data has been collected, all identifiers will be removed. The de-identified data will be securely stored on password-protected servers located at the UIC and will not be shared with anyone or any entity outside of the study group by any means.
If you have questions about your rights as a study subject; including questions, concerns, complaints, or if you feel you have not been treated according to the description in this form; or to offer input you may call the UIC Office for the Protection of Research Subjects (OPRS) at 312-996-1711 [or 1-866-789-6215 (toll-free)] or e-mail OPRS at uicirb@uic.edu.

Your participation in this online survey is immensely appreciated, and we thank you in advance for your valuable input. Together, we can work towards building a more efficient transportation system. Should you have any questions or require further information, please do not hesitate to reach out to the senior researcher, zhajib2@uic.edu

End of Block: Consent

Start of Block: Role of Respondent

Please indicate your role in the freight transportation process:★

- ○ I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).
- ○ I work for a third-party logistics provider (3PL), freight forwarder, or broker.
- ○ Other (Please specify your role) _____

End of Block: Role of Respondent

Start of Block: Introduction

This Survey is designed in 3 parts:

Part 1: Questions related to your establishment.
Part 2: Questions for **three** recent shipments.
Part 3: Your perceptions about energy transition.

End of Block: Introduction

Start of Block: Part 1 Description

Part 1: Information about your establishment

If you do not know the exact number for some of the questions, please provide approximate figures.

Please answer all questions, even if some seem uninteresting, as your complete responses are crucial for our research. Questions with a red star require an answer.

End of Block: Part 1 Description

Start of Block: Part 1 - General Questions

What is the location of your establishment?
Please provide the full address. If you prefer not to give the exact address, an approximate location with the street name will be helpful.
(This information is used for the study's geographical representativeness of the sample only. Your residential information will not be shared with anyone or any organization.)
_____

What is the total gross floor area occupied by your establishment?★
(You can select your preferred unit of measurement from the dropdown menu.)

_____

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

What is the average dollar value of weekly **inbound** shipments to your establishment?★

_____

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

What is the average dollar value of weekly **outbound** shipments to your establishment?★

_____

How many **paid employees** are currently working at this specific establishment?★
(You can provide an approximate number.)
Note: Please provide the employee count for this location only, not company-wide.

_____

Which of the following best describes your company's **primary** business?★
The primary business types are categorized into following:

- ○ **Agriculture, Forestry, Fishing and Hunting** {Including the production of crops, raising animals, harvesting timber or providing related support services.}
- ○ **Manufacturing** {Including food and textiles production, metal and chemical processing, machinery crafting, and the creation of furniture, medical supplies, and so on.}
- ○ **Wholesale Trade** {Including the bulk distribution of goods such as motor vehicle parts, furniture, construction materials, food, beverages, and health products to other businesses.}
- ○ **Mining**, **Quarrying**, and **Oil and Gas Extraction** {Or provides supportive services to these extraction activities.}
- ○ **Retail Trade** {Including the sale of goods such as food, beverages, electronics, and health products, along with vehicles and building materials.}
- ○ **Transportation and Warehousing** {Including handling the movement of goods or people via road, rail, air, water, or pipeline, and providing related storage and logistical support services}
- ○ **Information** {Including the provision of computing infrastructure, satellite telecommunications, and related services.}
- ○ **Construction** {Including buildings, paths, utilities and so on}
- ○ Other (You may provide the explanation of your company) _____

What is your primary mode of transport for shipments? ★
(Please select all that apply.)

- ☐ Truck
- ☐ Rail
- ☐ Air
- ☐ Water
- ☐ Courier or parcel carrier (e.g. FedEx, UPS)
- ☐ Pipeline
- ☐ I have no information.

Which of the following best describes the warehousing situation in your company?★
(Please check all that apply.)

- ☐ Own the Warehouse.
- ☐ Rent an **Entire** Warehouse (Public/Private).
- ☐ Rent **Part** of a Warehouse (Public/Private).
- ☐ Outsourced to a 3PL.
- ☐ Do not use Warehouses.
- ☐ I have no information.
- ☐ Other _____

End of Block: Part 1 - General Questions

Start of Block: part 1 - Number of Supplier

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Please fill out the following regarding the **major suppliers** of your establishment.
(A major supplier is one that consistently provides a significant portion of your goods or services, crucial for your business operations.)

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

How many **major** suppliers do you have?★
(Considering the most important suppliers)

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5+

Display This Question:

If How many major suppliers do you have?★ (Considering the most important suppliers) = 1

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 2

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 3

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 4

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 5+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

From your company's **first** major supplier:★

- What is the **average annual value** of orders in USD? _____
- What is the **annual total shipping cost** for those orders?(USD) _____
- What is the **average number of orders** per year? _____
- What is the **average annual weight** of goods? _____
- What is the **approximate distance** from your company to this supplier? (You can select your preferred unit of measurement from the dropdown menu.) _____

Display This Question:

If How many major suppliers do you have?★ (Considering the most important suppliers) = 2

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 3

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 4

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 5+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

From your company's **second** major supplier:★

- What is the **average annual value** of orders in USD? _____
- What is the **annual total shipping cost** for those orders?(USD) _____
- What is the **average number of orders** per year? _____
- What is the **average annual weight** of goods? _____
- What is the **approximate distance** from your company to this supplier? _____

Display This Question:

If How many major suppliers do you have?★ (Considering the most important suppliers) = 3

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 4

Or How many major suppliers do you have?★ (Considering the most important suppliers) = 5+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

From your company's **third** major supplier:★

- What is the **average annual value** of orders in USD? _____
- What is the **annual total shipping cost** for those orders?(USD) _____
- What is the **average number of orders** per year? _____
- What is the **average annual weight** of goods? _____
- What is the **approximate distance** from your company to this supplier? _____

End of Block: part 1 - Number of Supplier

Start of Block: Part 1 - Vehicles

How many commercial vehicles are currently owned or leased by your business?
If you have additional types of vehicles beyond those listed, please click '**Add More**' to input their details. You can click this button multiple times if you need to enter several different vehicle types.

- Light Vehicles _____
- Medium Vehicles _____
- Heavy Vehicles _____
- Trailers _____

What is the average number of **weekly** commercial vehicles arriving and departing your establishment?

	Company Owned	External Sources
Light / Medium Vehicles – **Arriving**		
Light / Medium Vehicles – **Departing**		
Heavy Vehicles / Trailers – **Arriving**		
Heavy Vehicles / Trailers – **Departing**		

What is the average number of **empty vehicles** arriving and departing from your establishment **weekly**?

	Company Owned	External Sources
Light / Medium Vehicles – **Arriving**		
Light / Medium Vehicles – **Departing**		
Heavy Vehicles / Trailers – **Arriving**		
Heavy Vehicles / Trailers – **Departing**		

Backhauling is when vehicles carry loads on their return trips to their base or depot, optimizing the journey.
Do your vehicles engage in backhauling? Please indicate the **approximate number** of vehicle trips that are engaged in backhauling **weekly**.
(If not engaged in backhauling, please enter 0)

_____

End of Block: Part 1 - Vehicles

Start of Block: Part 2 - Shipment 1 Description

Part 2: Recent Shipments Information

Shipment **number 1**

Please provide details about one of your most recent shipments. Specifically, choose a shipment that was **neither damaged nor delivered late.**

End of Block: Part 2 - Shipment 1 Description

Start of Block: Part 2 - Shipment 1

What was the **origin** of this shipment?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

What was the **destination** of this shipment?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Based on the major suppliers mentioned in the previous section, who is the supplier of this shipment?★

- ○ The first major supplier
- ○ The second major supplier
- ○ The third major supplier
- ○ Others

What was the primary nature of this shipment?★

- ○ Domestic
- ○ International

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = Domestic

Was this shipment being delivered to your establishment or being sent out?★

- ○ Inbound
- ○ Outbound

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

Regarding the international segment of this shipment, what was its nature?★

- ○ Import
- ○ Export

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

What was port of entry or departure of this shipment?
For instance, if it was an international shipment, a port of entry could be a major **airport** like O'Hare International Airport, or a **seaport** such as the port of Los Angeles _____

What was the approximate **dollar value** of the shipment?(USD)★
_____

What was the approximate **weight** of the shipment?★
(You can select your preferred unit of measurement from the dropdown menu.)

_____

What was the approximate **volume** of the shipment?★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping cost**? (USD)★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping time**? (days)★

- ○ Enter the value here. _____
- ○ I have no information.

Which of the following best describes the **industry category of shipment**?★
(Multiple selections allowed if the shipment includes various goods.)

- ☐ Agricultural products
- ☐ Chemical / Pharmaceutical products
- ☐ Coal / Mineral / Ores
- ☐ Electronics
- ☐ Gravel/ Natural sands/ Cement
- ☐ Machinery / Metal products
- ☐ Mixed freight / Miscellaneous
- ☐ Motorized and other vehicles (incl. parts)
- ☐ Prepared foodstuffs
- ☐ Wood / Paper / Textile / Leather products
- ☐ Other _____

Choose the commodity type of the shipment.★
(Please check all that apply.)

- [ ] Fragile
- [ ] Perishable
- [ ] Dry Bulk
- [ ] Liquid Bulk
- [ ] Hazardous
- [ ] None of them.

Please select any additional shipment characteristics that apply.★

- [ ] Expedited
- [ ] Time Sensitive (e.g. perishable goods)
- [ ] None of them.

What was the **main mode** of transportation for this shipment?★

- ○ Road - Truckload
- ○ Road - Less Than Truckload (LTL)
- ○ Rail - Carload
- ○ Rail - Container/Trailer
- ○ Air
- ○ Water
- ○ Courier or parcel carrier (e.g. FedEx, UPS)
- ○ Pipeline

Carry Forward Unselected Choices from "What was the main mode of transportation for this shipment?★"

What **other modes** of transportation were used for this shipment?★
(Please check all that apply)

- ☐ Other modes were not used.
- ☐ Road - Truckload
- ☐ Road - Less Than Truckload (LTL)
- ☐ Rail - Carload
- ☐ Rail - Container/Trailer
- ☐ Air
- ☐ Water
- ☐ Courier or parcel carrier (e.g. FedEx, UPS)
- ☐ Pipeline

What was the main reason for choosing this mode?

- [ ] Cost
- [ ] Speed
- [ ] Reliability
- [ ] Handling requirements
- [ ] Fuel efficiency
- [ ] Vehicle availability
- [ ] Other _____

What was the expected delivery time window at the destination for this shipment?

- ○ Less than 2 hours
- ○ 2 - 8 hours
- ○ 8 - 24 hours
- ○ 1 - 3 days
- ○ 3 - 5 days
- ○ Over 5 days

Was the shipment containerized?★
(Containerized cargo refers to goods that are transported using standardized shipping containers.)

- ○ Yes
- ○ No
- ○ I have no information.

Which of these facilities were employed during the transport of this shipment?★
(Please check all that apply.)

- ☐ Consolidation Center
- ☐ Distribution Center
- ☐ Warehouse
- ☐ None of them.

Please indicate the percentage of cost savings achieved through cargo consolidation for this shipment by adjusting the slider. If you're unsure or the question doesn't apply, please select the 'Not applicable / Don't know' option.

Not Applicable / Don't know.

	0 10 20 30 40 50 60 70 80 90 100
Percentage ()	

Which type of **equipment** did you use to transport this shipment?

▼ Any equipment was not used. (1) ... I have no information. (14)

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

For this shipment who made the shipping decisions?★

- ○ Receiving firm
- ○ Sending firm
- ○ Third-Party Logistics company (A company that handles the movement, storage, and distribution of goods for clients for a fee, without owning the products.)
- ○ Unknown / Not sure

End of Block: Part 2 - Shipment 1

Start of Block: Part 2- Distribution Channel- Shipment 1

For this shipment, please complete the **Transport Chain** from the first origin to the last destination that you are aware of. Choose the intermediate locations from the list and fill in the information about these locations. The first entry should be the **first stop after the origin.**

For this shipment how many intermediate facilities were used?★

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4+
- ○ I do not know.

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

What was the location of **first facility**?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **first facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **second facility**?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **second facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **third facility**? ★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **third facility** please answer following questions. ★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **fourth facility**?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **fourth facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

End of Block: Part 2- Distribution Channel- Shipment 1

Start of Block: Part 2 - Shipment 2 Description

Part 2: Recent Shipments Information

Shipment **number 2**

Please provide details about one of your most recent shipments. Specifically, choose a shipment that was **neither damaged nor delivered late.**

End of Block: Part 2 - Shipment 2 Description

Start of Block: Part 2 - Shipment 2

What was the **origin** of this shipment?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

What was the **destination** of this shipment?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Based on the major suppliers mentioned in the previous section, who is the supplier of this shipment?★

- ○ The first major supplier
- ○ The second major supplier
- ○ The third major supplier
- ○ Others

What was the primary nature of this shipment?★

- ○ Domestic
- ○ International

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = Domestic

Was this shipment being delivered to your establishment or being sent out?★

- ○ Inbound
- ○ Outbound

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

Regarding the international segment of this shipment, what was its nature?★

- ○ Import
- ○ Export

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

What was port of entry or departure of this shipment?
For instance, if it was an international shipment, a port of entry could be a major **airport** like O'Hare International Airport, or a **seaport** such as the port of Los Angeles.

_____

What was the approximate **dollar value** of the shipment?(USD)★
_____

What was the approximate **weight** of the shipment?★
(You can select your preferred unit of measurement from the dropdown menu.)
_____

What was the approximate **volume** of the shipment?★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping cost**? (USD)★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping time**? (days)★

- ○ Enter the value here. _____
- ○ I have no information.

Which of the following best describes the **industry category of shipment**?★
(Multiple selections allowed if the shipment includes various goods.)

- ☐ Agricultural products
- ☐ Chemical / Pharmaceutical products
- ☐ Coal / Mineral / Ores
- ☐ Electronics
- ☐ Gravel/ Natural sands/ Cement
- ☐ Machinery / Metal products
- ☐ Mixed freight / Miscellaneous
- ☐ Motorized and other vehicles (incl. parts)
- ☐ Prepared foodstuffs
- ☐ Wood / Paper / Textile / Leather products
- ☐ Other _____

Choose the commodity type of the shipment.★
(Please check all that apply.)

- ☐ Fragile
- ☐ Perishable
- ☐ Dry Bulk
- ☐ Liquid Bulk
- ☐ Hazardous
- ☐ None of them.

Please select any additional shipment characteristics that apply.★

- ☐ Expedited
- ☐ Time Sensitive (e.g. perishable goods)
- ☐ None of them.

What was the **main mode** of transportation for this shipment?★

- ○ Road - Truckload
- ○ Road - Less Than Truckload (LTL)
- ○ Rail - Carload
- ○ Rail - Container/Trailer
- ○ Air
- ○ Water
- ○ Courier or parcel carrier (e.g. FedEx, UPS)
- ○ Pipeline

Carry Forward Unselected Choices from "What was the main mode of transportation for this shipment?★"

What **other modes** of transportation were used for this shipment?★
(Please check all that apply)

- ☐ Other modes were not used.
- ☐ Road - Truckload
- ☐ Road - Less Than Truckload (LTL)
- ☐ Rail - Carload
- ☐ Rail - Container/Trailer
- ☐ Air
- ☐ Water
- ☐ Courier or parcel carrier (e.g. FedEx, UPS)
- ☐ Pipeline

What was the main reason for choosing this mode?

- [ ] Cost
- [ ] Speed
- [ ] Reliability
- [ ] Handling requirements
- [ ] Fuel efficiency
- [ ] Vehicle availability
- [ ] Other _____

What was the expected delivery time window at the destination for this shipment?

- ○ Less than 2 hours
- ○ 2 - 8 hours
- ○ 8 - 24 hours
- ○ 1 - 3 days
- ○ 3 - 5 days
- ○ Over 5 days

Was the shipment containerized?★
(Containerized cargo refers to goods that are transported using standardized shipping containers.)

- ○ Yes
- ○ No
- ○ I have no information.

Which of these facilities were employed during the transport of this shipment?★
(Please check all that apply.)

- ☐ Consolidation Center
- ☐ Distribution Center
- ☐ Warehouse
- ☐ None of them.

Please indicate the percentage of cost savings achieved through cargo consolidation for this shipment by adjusting the slider. If you're unsure or the question doesn't apply, please select the 'Not applicable / Don't know' option.

Not Applicable / Don't know.

	0 10 20 30 40 50 60 70 80 90 100
Percentage ()	

Which type of **equipment** did you use to transport this shipment?

▼ Any equipment was not used. (1) ... I have no information. (14)

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

For this shipment who made the shipping decisions?★

- ○ Receiving firm
- ○ Sending firm
- ○ Third-Party Logistics company (A company that handles the movement, storage, and distribution of goods for clients for a fee, without owning the products.)
- ○ Unknown / Not sure

End of Block: Part 2 - Shipment 2

Start of Block: Part 2- Distribution Channel- Shipment 2

For this shipment, please complete the **Transport Chain** from the first origin to the last destination that you are aware of. Choose the intermediate locations from the list and fill in the information about these locations. The first entry should be the **first stop after the origin.**

For this shipment how many intermediate facilities were used?★

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4+
- ○ I do not know.

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

What was the location of **first facility**?★

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **first facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **second facility**?★

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **second facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **third facility**? ★

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **third facility** please answer following questions. ★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **fourth facility**?★

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **fourth facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

End of Block: Part 2- Distribution Channel- Shipment 2

Start of Block: Part 2 - Shipment 3 Description

Part 2: Recent Shipments Information

Shipment **number 3**

Please provide details about one of your most recent shipments. Specifically, choose a shipment that was **neither damaged nor delivered late.**

End of Block: Part 2 - Shipment 3 Description

Start of Block: Part 2 - Shipment 3

What was the **origin** of this shipment?★
Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

What was the **destination** of this shipment?★

Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Based on the major suppliers mentioned in the previous section, who is the supplier of this shipment?★

- ○ The first major supplier
- ○ The second major supplier
- ○ The third major supplier
- ○ Others

What was the primary nature of this shipment?★

- ○ Domestic
- ○ International

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = Domestic

Was this shipment being delivered to your establishment or being sent out?★

- ○ Inbound
- ○ Outbound

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

Regarding the international segment of this shipment, what was its nature?★

- ○ Import
- ○ Export

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

What was the primary nature of this shipment? ★ = International

What was port of entry or departure of this shipment?
For instance, if it was an international shipment, a port of entry could be a major **airport** like O'Hare International Airport, or a **seaport** such as the port of Los Angeles.
_____

What was the approximate **dollar value** of the shipment?(USD)★

_____

What was the approximate **weight** of the shipment?★
(You can select your preferred unit of measurement from the dropdown menu.)
_____

What was the approximate **volume** of the shipment?★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping cost**? (USD)★

- ○ Enter the value here. _____
- ○ I have no information.

What was the approximate total **shipping time**? (days)★

- ○ Enter the value here. _____
- ○ I have no information.

Which of the following best describes the **industry category of shipment**?★
(Multiple selections allowed if the shipment includes various goods.)

- ☐ Agricultural products
- ☐ Chemical / Pharmaceutical products
- ☐ Coal / Mineral / Ores
- ☐ Electronics
- ☐ Gravel/ Natural sands/ Cement
- ☐ Machinery / Metal products
- ☐ Mixed freight / Miscellaneous
- ☐ Motorized and other vehicles (incl. parts)
- ☐ Prepared foodstuffs
- ☐ Wood / Paper / Textile / Leather products
- ☐ Other (_____

Choose the commodity type of the shipment.★
(Please check all that apply.)

- ☐ Fragile
- ☐ Perishable
- ☐ Dry Bulk
- ☐ Liquid Bulk
- ☐ Hazardous
- ☐ None of them.

Please select any additional shipment characteristics that apply. ★

- ☐ Expedited
- ☐ Time Sensitive (e.g. perishable goods)
- ☐ None of them.

Page Break

What was the **main mode** of transportation for this shipment?★

- ○ Road - Truckload
- ○ Road - Less Than Truckload (LTL)
- ○ Rail - Carload
- ○ Rail - Container/Trailer
- ○ Air
- ○ Water
- ○ Courier or parcel carrier (e.g. FedEx, UPS)
- ○ Pipeline

Carry Forward Unselected Choices from "What was the main mode of transportation for this shipment?★"

What **other modes** of transportation were used for this shipment?★
(Please check all that apply)

- ☐ Other modes were not used.
- ☐ Road - Truckload
- ☐ Road - Less Than Truckload (LTL)
- ☐ Rail - Carload
- ☐ Rail - Container/Trailer
- ☐ Air
- ☐ Water
- ☐ Courier or parcel carrier (e.g. FedEx, UPS)
- ☐ Pipeline

What was the main reason for choosing this mode?

- [ ] Cost
- [ ] Speed
- [ ] Reliability
- [ ] Handling requirements
- [ ] Fuel efficiency
- [ ] Vehicle availability
- [ ] Other _____

What was the expected delivery time window at the destination for this shipment?

- ○ Less than 2 hours
- ○ 2 - 8 hours
- ○ 8 - 24 hours
- ○ 1 - 3 days
- ○ 3 - 5 days
- ○ Over 5 days

Was the shipment containerized?★
(Containerized cargo refers to goods that are transported using standardized shipping containers.)

- ○ Yes
- ○ No
- ○ I have no information.

Which of these facilities were employed during the transport of this shipment?★
(Please check all that apply.)

- ☐ Consolidation Center
- ☐ Distribution Center
- ☐ Warehouse
- ☐ None of them.

Please indicate the percentage of cost savings achieved through cargo consolidation for this shipment by adjusting the slider. If you're unsure or the question doesn't apply, please select the 'Not applicable / Don't know' option.

Not Applicable / Don't know.

	0 10 20 30 40 50 60 70 80 90 100
Percentage ()	

Which type of **equipment** did you use to transport this shipment?

▼ Any equipment was not used. (1) ... I have no information. (14)

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

For this shipment who made the shipping decisions?★

- ○ Receiving firm
- ○ Sending firm
- ○ Third-Party Logistics company (A company that handles the movement, storage, and distribution of goods for clients for a fee, without owning the products.)
- ○ Unknown / Not sure

End of Block: Part 2 - Shipment 3

Start of Block: Part 2- Distribution Channel- Shipment 3

For this shipment, please complete the **Transport Chain** from the first origin to the last destination that you are aware of. Choose the intermediate locations from the list and fill in the information about these locations. The first entry should be the **first stop after the origin.**

For this shipment how many intermediate facilities were used?★

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4+
- ○ I do not know.

Display This Question:

If Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

And If

For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

What was the location of **first facility**?★
Please enter the detailed and full address for the location. Use the search bar to type the address.
_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 1

Or For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

Q848 For the **first facility** please answer following questions.★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **second facility**? ★
Please enter the detailed and full address for the location. Use the search bar to type the address.
_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 2

Or For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **second facility** please answer following questions. ★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **third facility**? ★

Please enter the detailed and full address for the location. Use the search bar to type the address.

_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 3

Or For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **third facility** please answer following questions. ★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

What was the location of **fourth facility**? ★
Please enter the detailed and full address for the location. Use the search bar to type the address.
_____

Display This Question:

If For this shipment how many intermediate facilities were used? ★ = 4+

And If

Please indicate your role in the freight transportation process: ★ = I am employed at a company/establishment that ships goods (e.g., manufacturer, retailer).

Or Please indicate your role in the freight transportation process: ★ = I work for a third-party logistics provider (3PL), freight forwarder, or broker.

Or Please indicate your role in the freight transportation process: ★ = Other (Please specify your role)

For the **fourth facility** please answer following questions. ★

	Facility Type	Mode used to reach this location	Haul time from previous location	Wait time at this location
Please select the answer.	▼ Distribution Center (1 ... Intermodal Facility	▼ Road - Truckload (1 ... Pipeline	▼ Less than 2 hours (1 ... Over 5 days	▼ Less than 2 hours (1 ... Over 5 days

End of Block: Part 2- Distribution Channel- Shipment 3

Start of Block: Sustainability concern

Part 3: Energy Transition Concerns

In the following, there are some questions regarding your opinions and perceptions of energy transition.

Please provide your opinion for each statement about climate change.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I believe it is essential to reduce greenhouse gas emissions to mitigate climate change.	○	○	○	○	○
I am very concerned about the impact of climate change on the environment.	○	○	○	○	○
Recent extreme weather events have influenced my views on the urgency of addressing climate change.	○	○	○	○	○
Media coverage on climate change accurately reflects the severity of the issue.	○	○	○	○	○
I feel that public opinion on climate change is often influenced by misinformation.	○	○	○	○	○
Political discussions about climate change impact my views on how we should manage energy resources in logistics.	○	○	○	○	○
In my opinion, freight logistic services should shift from fossil fuels to sustainable energy sources.	○	○	○	○	○
I think the use of electric trucks should be prioritized to enhance sustainability in our logistics operations.	○	○	○	○	○
I believe hydrogen fuel technology is helpful for sustainable transportation.	○	○	○	○	○

Suppose that you are transitioning from fossil fuels to sustainable energy sources. How concerned are you about each of the following factors when choosing sustainable fuels for transporting your shipments?
Please rate each factor from 1 to 5, where 1 is "Not important at all" and 5 is "Very important.

	Not Important at All	Slightly Important	Important	Fairly Important	Very Important
High Initial Cost of Purchasing New Vehicles - High upfront cost to buy new sustainable vehicles.	○	○	○	○	○
Cost of Additional Services - Expenses for extra services like software upgrades, training, and adapting infrastructure.	○	○	○	○	○
Decreased Fuel Costs -Lower expenses because sustainable fuel is cheaper than fossil fuels.	○	○	○	○	○
Higher Maintenance Costs: Increased costs for maintaining new technology and specialized equipment.	○	○	○	○	○
Availability of Labor or Maintenance Services - Access to skilled workers and services for maintaining new vehicle technologies.	○	○	○	○	○
Availability of Charging Stations - Enough charging facilities for electric vehicles.	○	○	○	○	○

Changes in Operational Planning - Adjust routes and schedules to fit charging station locations.	○	○	○	○	○
Increased Time Required for Refueling More time needed to charge electric vehicles compared to refueling traditional ones.	○	○	○	○	○
Reduction in Greenhouse Gas Emissions - How much switching to sustainable vehicles lowers emissions compared to conventional fuels.	○	○	○	○	○
Increased Delivery Time Due to Recharging - Delays in delivery schedules caused by the time taken to recharge electric vehicles.	○	○	○	○	○
Receiving Government Policies (e.g., Tax Incentives) - The impact of government policies, such as tax returns and incentives, on making the transition more affordable.	○	○	○	○	○

Please provide your opinion about sustainable practices in freight logistics.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The potential economic impact of transitioning to renewable energy in the logistics sector concerns me.	○	○	○	○	○
Environmental considerations in shipments induce higher costs for our company.	○	○	○	○	○
I believe transportation modes that have a lower environmental impact are better for shipping, even if they are more expensive.	○	○	○	○	○
In operation planning, we select the route with the lowest emissions.	○	○	○	○	○
Receiving subsidies from the government plays a crucial role in transitioning vehicles from diesel to electric or hydrogen.	○	○	○	○	○
The use of electric vehicles in delivery increases delivery time.	○	○	○	○	○
We publish an annual report about the environmental impacts of the operations of the organization.	○	○	○	○	○

I plan to allocate a part of my budget to invest in renewable energy technologies in the near future.

- ○ Definitely not
- ○ Probably not
- ○ Maybe
- ○ Probably
- ○ Definitely

I am ready to initiate projects to incorporate renewable energy into my business operations.

- ○ Definitely not
- ○ Probably not
- ○ Maybe
- ○ Probably
- ○ Definitely

I am willing to adopt renewable energy solutions even if it requires significant changes to current practices.

- ○ Definitely not
- ○ Probably not
- ○ Maybe
- ○ Probably
- ○ Definitely

End of Block: Sustainability concern

Start of Block: Contact information

Thank you for participating. You can win a **$100 Amazon gift card**. We will select 20 winners by lottery. To enter, please provide your email address below. _____

Please provide any additional comments you may have.

_____

End of Block: Contact information

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