Title

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Publication Date

2023-09-01

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September 1, 2023

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Prepared for the California Air Resources Board and the California Environmental Protection Agency pursuant to Agreement 19RD010.

UCDAVIS Institute of Transportation Studies

Reference No. UCD-ITS-RR-23-61

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ACKNOWLEDGEMENT

The authors acknowledge the essential contributions of David Schaller and Mike Roeth of The North American Council for Freight Efficiency and Ben Sharpe and Jerold Brito of the International Council on Clean Transportation. The authors bear sole responsibility for the work presented here.

This Report was submitted in fulfillment of Agreement Number: 19RD010, Determinants of Medium- and Heavy-Duty Truck Fleet Turnover by the University of California, Davis under the sponsorship of the California Air Resources Board. Work was completed as of 7 September 2022.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

This study solicited information directly from decision-makers in private businesses operating fleets of medium- and heavy-duty trucks in California via interviews and pre-interview questionnaires. Additional interviews were conducted with truck manufacturers, consultants and other businesses providing services to the freight industry including leasing and auction. All these data were collected in 2021 and 2022. Fleet decision-makers describe what determines when and why they acquire and retire trucks and how they use those determinants. The purpose is to better understand vehicle turnover in the trucking sector. Direct contact with fleet decision-makers was preceded by a review of relevant literatures. This review helped in the design of joint questionnaires and interview protocols. Results are presented as 1) a set of determinants (internal to each fleet, external, and linking internal to external), 2) a typology based on decision-making structure, adaptation, and complexity, 3) case studies of decision-making types, 4) generalizations across fleets, and 5) extension to fleet consideration of alternative fuel trucks. One overarching conclusion is drawn: fleet truck turnover behavior varies widely—our highest-level abstraction—the typology—results in more than 20 types among 90 fleets allowing that some types involve mixed types of structure, adaptation, and/or complexity. Few fleets' decision-making conforms to the commonly assumed model of total cost of ownership; many more do not. This report describes the varied ways fleets acquire and retire trucks, extends this to understand how this variety is already affecting freight fleets' consideration of alternative fuel trucks, and poses questions as to how understanding this variety aids in promotion of zero-emission trucks.

EXECUTIVE SUMMARY

Regulation by California and the federal government coupled with greenhouse gas (GHG) reductions targets require rapid market penetration of zero emission trucks into fleets operating medium- and heavy-duty trucks in California. The California Air Resources Board (CARB) has adopted and proposed regulations to ensure the state can meet regulatory air quality standards and GHG reduction targets. To estimate the effects of these regulations on the trucking sector, CARB requires a better understanding of fleets' decision-making in acquiring and retiring medium- and heavy-duty trucks.

Based on direct input from decision-makers involved in truck acquisition and retirement, this study identified determinants of private-sector freight fleet turnover of their medium- and heavy-duty trucks. Further, a typology of fleet decision-making was derived. The determinants and typology organize discussion at the fleet-level. General observations are offered across fleets. The analysis extends beyond conventional gasoline- and diesel-fueled trucks to produce a ranked list of stated barriers and motivations to electric trucks.

The study was based on two research tasks. Task 1 was a literature review of factors influencing truck turnover. In addition to searches of on-line databases, professional contacts with expertise in fleet operations augmented the literature search. The literature review identified, organized, and summarized information related to truck turnover. These results aided in designing the major research task, Task 2: interviews with decision makers in fleets operating medium and/or heavy-duty trucks in California, manufacturers of such trucks, and service providers to fleets such as consultants, leasing companies, and truck auction houses. The interviews used protocols tailored to the type of interviewee, e.g., fleet, manufacturer, or service provider. Fleets were sampled across multiple vehicle weight classifications, use cases, and fleet sizes. Fleets did not have to be headquartered in California but must have operated trucks in the state. Some prospective interviewees were identified through professional relationships with members of the study team, but the vast majority were selected from public lists of truck fleet managers and a licensed version of a private database of fleets operating in California. Ultimately, 99 interviews were conducted of which 89 were with fleets. Given the research design, results should be treated as a rich description of the participating fleets; extensions of numerical results from this sample, for example percentages of fleets who make decisions this way or that way, to all fleets operating medium and/or heavy-duty trucks in California or even all fleets of a particular size or use case may produce inaccurate results. Interviews were conducted in 2021 and 2022.

Among the foremost conclusions is that fleets operating medium- and heavy-duty trucks in California interviewed for this project vary widely in their fleet turnover practices. Further, most fleets acquire and retire trucks in ways not consistent with the total cost of ownership (TCO) metric oft used by academic, regulatory, and policy analysts. As the name implies, TCO assesses the total cost to acquire and operate a truck until it is retired from use. Beyond that general description, few TCO practitioners agree on all the costs that should be included or how uncertainty should be treated.

Few of the interviewed fleets use TCO and those who say they do don't agree on what it is. Neither fuel cost nor fuel economy are routinely assessed by many fleets despite the fact fuel and labor are likely their two highest costs. Maintenance costs are widely used to assess when it is time to retire a truck, but few fleets make this assessment within a cost calculation framework that compares maintenance to other costs or incorporates maintenance costs with others into a summary cost measure.

More commonly, fleets reported using heuristics—simple rules based on simple metrics. For example, a truck retirement might be based on a repair cost heuristic such as, “sell a truck when the cost of a required major repair exceeds the trucks resale value.” Many fleets use a simple total-miles heuristic: when a truck reaches a threshold number of miles, they retire it or at least review it for retirement. The threshold number of miles appears to be shorter for medium duty trucks (sometimes as short as 100,000 miles) and longer for heavy-duty (ranging in our data from approximately one-half to three-quarter million miles). Brand loyalty is one truck acquisition heuristic; positive experience with a truck brand and a good relationship with a dealership may substitute for time and effort spent to compare available trucks.

According to leasing companies interviewed for this research, leasing is presently increasing its share of all new truck acquisitions. Leasing can simplify fleet management as costs of truck maintenance, inspections, reporting, and emissions testing are shifted to the leasing company. Truck turnover may be determined by lease periods rather than any metric of vehicle cost or performance as trucks are likely to be returned to the leasing company at the end of the lease.

Determinants of truck turnover heard in the interviews were classified into three categories—internal, external, and linking internal to external. Internal determinants are internal to a fleet. They include acquisition (purchase, lease, or rent) costs, maintenance costs, fuel efficiency or fuel costs, driver satisfaction, possibly a summary measure of two or more types of costs, and others. External determinants affect all fleets operating in California. They include regulations such as mandates for diesel emission fluid (DEF) systems, prohibitions on registering older vehicles, port truck rules, prohibitions on classifying workers as independent contractors (per Assembly Bill 5), and rules affecting accounting practices for leasing. In addition, truck and driver availability became important external determinants during the study period because of supply chain disruptions related to the COVID-19 pandemic. Determinants linking internal and external considerations pertain to social and business networks including brand or dealer loyalty.

Some external determinants are knowable in advance, yet some fleets we classified as reactive operated without such knowledge. Such fleets, for example, reported they only learned a truck was no longer compliant when attempting to renew its registration. Other fleets we classified as proactive executed truck turnover plans which anticipate requirements. Some external effects could, perhaps, not be anticipated; examples include COVID-19-related supply chain disruptions limiting truck availability and worsening driver shortages. Some fleets’ desire to retain drivers caused them to turn their fleets over faster.

Because of the variation between even operationally similar fleets in how determinants influence truck turnover decision-making, a typology of decision-making was derived. The typology was built on three dimensions of decision-making: Structure, Adaptation, and Complexity. Structure describes how decision-making is organized: group (hierarchical, egalitarian, or siloed) or sole (single person). Adaptation describes whether decision-making leads (proactive) or follows (reactive) external factors. Complexity reflects the number of determinants, as well as the existence and intricacy of both systems to collect data on those metrics and algorithms to apply and combine determinants into truck acquisition and retirement decisions. Complexity is scored as simple or complex. Based on the assignment of fleets to types, pairs of fleets were selected for case studies of decision-making types. These case studies reinforce the central conclusion: even at the level of decision-making types, we observe diversity and variation in fleet truck turnover decision-making.

Many fleets described episodes and events which forced them to scrap routine ways of doing things, suggesting openings may be created for fleets to think differently about alternative fuel trucks. Focusing on battery electric trucks, the interviewed fleets' most commonly mentioned barriers to acquisition were lack of charging infrastructure, acquisition cost, driving range, model availability, vehicle weight, and charging time. The list of top positive motivating factors includes regulations, internal goals, incentives, emission reductions, available demonstration projects, and electric truck power and torque. The complexity of demonstration programs can be a barrier to participation. Large leasing companies may be better able to internalize uncertainties in new technology costs than smaller fleets suggesting leasing has the potential to ease at least the barrier of initial acquisition cost.

Research recommendations include both improvements to the study design of potentially any study of fleets operating medium or heavy-duty trucks as well as new research that follows from the results of this work. This study's sampling design did not distinguish between use cases for medium-duty trucks; future work should do so, at a minimum distinguishing between long-haul and short-haul. The categorization of fleets according to size has no consistent basis in the literature. Given that the number of trucks is correlated with the Structure and Complexity dimensions of the decision-making typology, an extension of this work would test for whether number of trucks is the best measure of size (as opposed to say, gross revenue or number of employees). A focused study of truck leasing seems important as leasing appears to generally increase the rate of turnover and may be increasing its share of truck acquisitions.

To the extent fleets' truck acquisition and retirement decisions are shaped by internal determinants, decision-making is inward looking, i.e., fleets are not using data from the thousands of vehicles like theirs operated by other fleets. Further, consideration of a new type of truck, such as electrics trucks, may require a new, outward-looking way of thinking about acquiring and retiring trucks. Both to make truck turnover decisions more outward-looking, i.e., to use more external determinants, and to shape those external determinants to highlight data on electric trucks, research into the design of, and fleets' responses to, systems that allow fleets to see data from many trucks other than their own may prove useful.

Finally, the question arose whether there are direct health benefits to truck drivers from truck electrification. This seems likely to be true for reduced exposure to tailpipe emissions, but possibly also true based on reduced exposure to truck vibration and noise over the course of many hours of daily operation over the course of time.

INTRODUCTION

To reduce pollution and mitigate the effects of climate change, state and national legislation has established air quality goals (California Air Resources Board, 2021a), and California executive orders have set aggressive greenhouse gas reduction targets (Brown, 2018; Newsom, 2020). To meet these goals and targets, trucking fleets in California must incorporate cleaner vehicles, alternative fuels, and zero emission vehicles (ZEVs) wherever possible. The California Air Resources Board (CARB) has adopted several regulations to enable this transition including the Truck and Bus regulation (California Air Resources Board, 2020), the Drayage Truck regulation (California Air Resources Board, 2007), the Advanced Clean Trucks regulation (California Air Resources Board, 2019), and the Advanced Clean Fleets regulation (California Air Resources Board, 2021b). To estimate the effects of these rules, CARB requires a better understanding of how fleets make truck acquisition and retirement decisions.

This project focuses on the factors that fleets operating medium and heavy-duty trucks in California use to determine when to acquire trucks, which trucks to acquire, and when to retire vehicles. The terms "acquire" and "acquisition" include purchase, lease, and rent. "Retire" and "retirement" refer only to removal of a truck from active use by a particular fleet; they do not refer to the ultimate removal of a truck from on-road service anywhere. A truck retired from one fleet in the sense we mean "retired" may be acquired and put into service by another fleet. "Turnover" is the combined activities and effect of acquisition and retirement.

The goal is to define the factors or determinants of truck fleet turnover and to describe fleets' decision-making. While all private trucking fleets operating vehicles in California were eligible for the study, priority was given to commercial interstate long-haul, intrastate delivery, drayage, and medium-duty delivery trucks operating in California. One output of the research is a typology of fleet turnover decision-making behaviors. The typology places the interviewed fleets into a framework summarizing how types of fleets make their fleet turnover decisions. The report includes case studies to illustrate the decision-making types; each case study compares two fleets of the same type. To foreshadow the overall conclusion drawn from this study, despite the fact both fleets in a case study share decision making structure, complexity, and adaptation, each case study ultimately shows how different two fleets may be regarding truck acquisition and retirement. In addition, the study provides a ranked list of barriers to the adoption of alternative fueled trucks (i.e., battery and fuel cell electric and natural gas).

The study utilizes two main methods to acquire information about fleet truck turnover decision-making. The first is a literature review related to the factors that influence or predict medium- and heavy-duty truck fleet turnover. The literature review includes a wide range of reports, studies, and papers that focus on various aspects of fleet turnover decision making such as fleet characteristics, decision making tools, acquisition of conventionally fueled trucks, emergent technologies, alternative fuels, relevant policies, and end of life decisions. While some studies incorporate information gleaned directly from fleets, few studies past rely on many direct interviews of fleets and related businesses.

The second is interviews of trucking fleets, truck manufacturers, and businesses that provide services to truck fleets. The interviews followed protocol tailored to each of those three groups. Questions were designed to elicit information on the determinants and processes of truck fleet turnover. A link to an on-line questionnaire was sent to all interviewees before their interview to provide a general understanding of the business.

The study consisted of these three tasks: 1) literature review, 2) direct communication with industry sources (generally, questionnaires and interviews), and determinants documentation, and 3) summary and synthesis of information from 1) and 2). The products of 3) include the typology, decision-making case studies, and barriers and opportunities for alternative fuels. The report structure includes a Materials and Methods section describing how each task was performed, a Results section describing the outputs from each task in order, a Discussion section including results from the interviews along with the fleet typology and case studies, a Summary and Conclusions section presenting the most important results of the analysis, and a Recommendations section suggesting potential future studies to delve deeper into certain questions that could not be answered from this study.

MATERIALS AND METHODS

Task 1: Literature Review

The purpose of Task 1 was to review information concerning how fleet managers make decisions on the acquisition and disposal of medium- and heavy-duty trucks. This review process began with identifying key search terms, as well as relevant search engines and academic journals. We searched within these using search terms. To increase the likelihood of finding relevant results, these terms were generally used in combination with each other or words such as "fleet," "truck," or "vehicle." Search terms included:

- heavy-duty, medium-duty, drayage, long-haul, delivery, port
- diesel, natural gas, fuel cell, battery
- technology, policy
- freight
- purchase, purchasing, lease, leasing
- decision making, factors
- choice model
- maintenance, fuel economy, payback period
- scrappage, retirement, repowering
- electrification, zero emission, sustainability
- emerging technology
- business models
- turnover, survival, scrappage
- compliance requirements
- tax policies, accounting, financial practices
- incentive, funding
- obstacles, barriers
- regulation, regulatory impacts
- business cycle
- total cost of ownership, TCO, lifecycle analysis, cost

In addition to searching online, we utilized professional contacts with expertise in freight fleets to request information such as references to literature, especially reports in the "gray" literature such as consultant reports that may be less likely to be indexed in on-line databases.

Task 2: Direct Communication with Industry Sources

The purpose of Task 2 was to collect information about fleet turnover determinants directly from relevant decision makers in fleets and other industry sources. The methods to do this were linked questionnaires and semi-structured interviews, i.e., each participating source completes both. Potential participants, i.e., the population from which participants were recruited, were executives of businesses that operate fleets containing medium- and heavy-duty trucks, manufacture and supply such trucks, or provide consulting or other advisory services to such fleets. The phrase "manufacture and supply" is interpreted to include original equipment truck manufacturers, customizers who buy "basic" trucks and modify them for vocational or other specialized uses, and businesses that lease or rent trucks to fleet operators. The population of fleets was limited to private businesses. Documentation of the interview and questionnaire results are presented in this section; the questionnaire and interview protocols are provided in Appendices A and B. Summaries were assembled of each fleet interviewed and are included in Appendix C.

Four categories of fleets were specified for recruitment: 1) interstate long-haul, 2) intrastate delivery, 3) drayage/port fleets (focusing in these first three on fleets using heavy-duty trucks, (GVWR classes 7-8)), and 4) pick-up and delivery fleets using medium duty trucks, (GVWR classes 2b-6). While conducting and summarizing interviews, few compelling distinctions were heard between the first two while the case of medium-duty trucks (especially Class 6 box trucks) appeared to be a more distinctive truck-type/use cases.

Interviews with fleet operators as well as fleet vehicle and service providers gathered information about:

- How private fleets decide what vehicles to acquire and dispose of, and when to buy, sell, reconfigure, or scrap them, including how fleet operators search for and choose among replacement vehicles.
- Who acquires used trucks and subsequent use and disposal.
- Fleet-specific vehicle purchase/sale prices, lease terms, operations, and maintenance costs, and patterns of use.
- The influence of changing transportation technologies, including obstacles to and incentives for adoption/retention of alternative fuel trucks.

Task 2 built profiles of each participating fleet as well as groups of fleets using their questionnaire and interview data. These descriptions include a set of individual fleet profiles to build a knowledge base of how trucks are bought, used, and retired, including how change happens and can happen in the composition of medium- and heavy-duty truck fleets. These profiles descriptions of individual fleets and case studies of decision-making types that exemplify how truck buying, use, and retirement are happening and how they affect and are affected by changes in technology, services, and business models.

Task 2.1: Instrument and Sampling Design

Primary data were collected in interviews preceded by a brief questionnaire; copies of these are in Appendices A (questionnaire) and B (interview protocol). Versions of the interview protocol were prepared for different types of organizations: fleets, manufacturers and suppliers, leasing companies, and consultants. Within fleets, different protocols were designed for those who acquire new, used, or both new and used trucks as well as those fleets who buy, lease, or rent, or acquire their trucks via some combination of these. As variations in fleet protocols primarily served to remind interviewers of differences in wording of specific questions rather than major topical areas, only the protocol for fleets that acquire trucks via some combination of purchase, lease, and rental is provided in Appendix A.

The protocol is the outline of questions that guide each interview. Interviews were conducted in a semi-structured manner: while there is an outline of topics and questions the interviewers wish to cover, respondents were allowed and encouraged to speak at length in their own words. As such, the actual conversation may jump ahead to topics later in the protocol, circle back to topics already discussed, and introduce new topics not in the protocol. As such, each interview was dynamically managed by the interviewers to assure both comparability across interviews of common topics and flexibility within each interview to learn new and unexpected information.

The pre-questionnaire collects basic information that allows each interview to be assigned to the sampling framework, confirms interviewees' role and contact information, and describes the ownership structure of the fleet. These data include means of acquiring trucks, number of trucks by weight class(es) and use case(s), and experience with trucks with hybrid drivetrains, trucks powered by alternative fuels, and electric trucks.

The sampling framework is a matrix to be populated with interviews. The dimensions of the matrix were formed by concepts expected to affect fleet truck acquisition, use, and retirement across a variety of applications and organizations. No basis was found during the Task 1 Literature Review to alter the sampling framework in the original project proposal. The main dimensions are: 1) organization type including fleets (distinguished by classes based on the number of trucks operated by the fleet), suppliers, and consultants, and 2) four use cases including long-haul (heavy-duty), short-haul delivery (heavy- and medium-duty), drayage (heavy-duty), and all other medium-duty.

Task 2.2: Recruit Participants

Several factors extended the intended period to recruit participants and conduct interviews, not least of these was the overlap in the intended interview period and the onset of the COVID-19 pandemic. Project partner NACFE offered also that they too had experienced a sharp reduction in participation of fleets in many of its studies, citing the rapid increase in requests for fleet operators time to discuss several new technologies including truck electrification and automation. Ultimately, 99 of the planned 100 interviews were completed. Several sampling methods and lists were deployed from Winter 2020 through the Summer of 2021 including:

- Attendee list for a joint California Energy Commission and California Air Resources Board Drayage Workshop (cleaned to include only contacts for private fleets, $n > 200$).
- An industry Container Chassis contact list ($n_{total} \approx 3{,}000$).
- Port of Los Angeles Concessionaire contact ($n_{total} \approx 1{,}200$.

- Prospect lead list ($n_{total} \approx 33{,}000$; $n_{contacted} = 1{,}439$).
- UC Davis Fleet Survey ($n_{total} = 364$; $n_{contacted} = 54$).

Distinctions between total list sizes (n_{total}) and the number of contacts ($n_{contacted}$) are largely due to the availability of an e-mail address in the contact data, excluding e-mail addresses obviously not within the desired population (e.g., excluding .gov, .org., and .edu domains), and matching organization and fleet types to the sampling framework.

Additionally, several personal and professional networks were enlisted to help recruit participants:

- Personal contacts of project principals at the UC Davis Sustainable Freight Program, North American Council for Freight Efficiency (NACFE), and TechTruth Consulting.
- The American Trucking Association (ATA, which issued an invitation to members).
- The California Trucking Association (which deferred to the ATA).

By early summer 2021, 35 interviews had been conducted. At that time no additional interviews were successfully recruited. Experimenting with presenting the interview as a 30-minute conversation rather than the original 60-minutes produced no additional interviews. Prolonged efforts to gain access to commercial lists resulted in the purchase of a one-year license to a database containing contact information (and other information necessary for sampling) for all entities operating Class 2b to Class 8 trucks in California. With those data, recruiting successfully resumed in Spring 2022. The sample is described in Table 1 in the Results.

Task 2.3 Conduct Interviews

Interviews started in winter 2021 and concluded in fall 2022. While some initial interviews were planned to be conducted in person, restrictions on travel and access due to the COVID-19 pandemic necessitated all interviews be done remotely. All interviews were conducted by teams of two researchers. Semi-structured interviews require attention to both content and process as any given interview will not follow the protocol precisely. While one interviewer focuses on being engaged in what should sound more like a conversation than a reading of a list of questions, the other attends to being sure all the content is covered and provides a first-person account of the interview to support subsequent analysis. (Researchers routinely swap these roles during each interview.) Pre-preparation for each interview included prior review of the interviewee’s pre-interview questionnaire responses and, in some cases, searches for on-line information such as the company’s website.

Task 2.4 Preparing Interview Transcripts

As noted, most interviews were recorded, and all recorded interviews are transcribed. The transcriptions created by the virtual meeting platform used to conduct the interviews are generally of low quality, containing many misidentified words and phrases and failing to properly distinguish speakers. These automatic transcriptions was reviewed and corrected by one of the interviewers or another research team member to clean and correct it for analysis.

Task 3: Synthesis

Information from Tasks 1 and 2 were analyzed and synthesized to create four sets of results: 1) a list of “determinants” of fleet’s truck acquisitions and retirements, 2) a fleet turnover decision-making typology including case studies illustrating how the determinants are used in the different decision-making types, 3) a ranked list of obstacles to fleet adoption of alternative-fuel (electricity, hydrogen and RNG) trucks, and 4) general conditions affecting broader trends in fleet turnover.

The existence of an interview protocol may give the impression of a greater sense of order than is achieved in any given interview. Semi-structured interviews are constructed in conversation with the interviewee based on the protocol—representing the research questions—and interviewee's knowledge of their fleet. Thus, interviews deviate from the protocol order as well as introduce new information not anticipated by the protocol.

Themes; Determinants

Because interviews were semi-structured, answers to the research questions often must be assembled from material throughout the interview. After creating the corrected transcript, a researcher reads through the record several times to locate patterns, reoccurring themes, and passages related to the questions of when, why, and how fleets acquire and retire their medium- and heavy-duty trucks. These themes are categorized according to the major objectives of the study. The interviews are coded according to these themes so that text from each interview can be re-assembled into the topics of interest. For example, a firm's strategy for buying trucks will likely not be contained in an interviewee's single statement but must be read in several parts of the interview. Thematic coding allows all statements about each theme, truck acquisition behavior in this example, to be assembled into the set of statements relevant to the theme. Further, these statements are then collected across interviews. Typically, one researcher identifies themes and codes the transcript. The other interviewer from that interview reviews the themes and the coded transcription. The second reviewer questions and/or concurs with the coding. These coded transcripts are the basis for identifying determinants, summarizing each interview, preparing for case studies, and synthesizing results across interviews in the forms of a typology of decision making and generalizations.

Knowing the research objectives, the themes are not the result of open coding. (In open coding, the first reading of a transcript is not looking for specific information, but is a reading to answer the question, "What does this say?" This is in distinction from a first reading to answer the questions, "What does this say about how and why fleets acquire and retire trucks," as we did here.) The themes are (by and large) the determinants of fleet turnover: what causes fleets to acquire and retire trucks.

Summaries, Typology, Case Studies, Generalization

Summaries are prepared based on data from each interviewee's pre-questionnaire (when available) and prepared transcript. Summaries are based on a template to increase comparability across fleets and consistency between summaries prepared by different researchers. In general, descriptive data used to categorize the interview within the sampling framework are presented first. Then, assessments of the adaptability and decision-making structure which inform the placement of the fleet in the decision-making typology are presented. The last two sections are direct answers to the questions, what determines truck turnover in that fleet and how are those determinants applied. First, these questions are answered in a very brief, highly distilled form, possibly a simple list of determinants followed by a two- to three-sentence statements. Second, these are expanded through the provision of context, examples, and quotes to support those answers.

Identification of determinants and preparation of summaries provide the insights to develop a typology of decision making and the preparation of case studies to illustrate the types. Generally, a typology organizes items into sets in which items of a type are more like each other than they like items of a different type. Formulation of the typology was done through an inductive process, building on information recorded in the interviews. There was too little information found in the Task 1 Literature Review to formulate any hypotheses about what a typology of fleet turnover decision-making should be. As the only directly relevant literature (Nesbitt and Sperling, 2001) was conducted more than twenty years ago among fleets operating only light-duty vehicles, this research does not test a typology, but builds a typology from its data.

The inductive approach lends itself less to a clear distinction between method and result beyond the generalizations that the typology was a topic of repeated conversation over a period of months as additional interviews were conducted. Given we were hearing similar determinants in operationally different fleets and different determinants in operationally similar fleets, operational attributes, e.g., size, truck class, use case, and such, were not useful for a typology of decision making.

At the same time, we were hearing determinants that were in fact "determining" in the sense of proscribing possible actions and that these proscriptions could be either external or internal to a given entity operating a fleet of medium- and/or heavy-duty trucks. For examples, public policy and global pandemics are external to a given entity while an entity's decision-making structure is internal. Internal factors can be assigned to a specific entity and thus used to assign them to a type. (External determinants are described in sections on generalizations across fleets.) Subsequent conversations among the researchers addressing the question of what typology would usefully organize a presentation of fleet decision making developed distinctions between the complexity of fleet turnover decisions; where did fleets fit on a scale from the use of one or a few operational heuristics to complex cost and operations modeling? Where did fleets fit on a scale from reactive, i.e., solving a problem after it is already a problem, vs. proactive, i.e., planning, experimenting, or otherwise anticipating potential problems? This continual probing of the data as we accumulated interviews resulted in the typology described in the Results. We do not represent the resulting typology is the only one possible; we are confident it is grounded in the data provided to us by fleet decision-makers as well as consultants to fleets and truck manufacturers.

Once the typology was created, fleets were assigned to types. Two fleets of a type are included in that type's case study. This allows for some comparison to illustrate (in some cases) how operationally different fleets may share a decision-making type and contrast to illustrate (in other cases) how operationally similar fleets are of different decision-making types.

The process of writing summaries, creating a typology, and writing case studies of types yielded generalizations of results applicable across many fleets.

RESULTS

Task 1: Literature Review

This review synthesizes literature on medium- and heavy-duty truck turnover decisions including an overview of fleet characteristics, decision making tools, acquisition decisions for gasoline- and diesel-fueled medium and heavy-duty vehicles, emergent technologies, alternative fuels, relevant policies, and truck retirement decisions. This review reveals both the variety of fleet decision making and shows that there continue to be significant gaps in the literature concerning how these decisions are made.

Medium- and heavy-duty vehicles made up just 5% of the more than 260 million registered vehicles in the US in 2021 (U.S. DOT, 2023a), yet they are responsible for 23% of US greenhouse gas emissions from transportation (U.S. EPA, 2020). One reason for this is the high average annual use of these vehicles: a new class 8 long haul tractor averages around 100,000 miles per year (Birky *et al.*, 2017). Though these trucks produce high emissions, they drive the economy: the US Department of Transportation estimates approximately 12.5 billion tons of freight were moved in 2020, 71 percent of it by on-highway trucks, valued at $10.4 trillion (U.S DOT 2023b). Freight trucks account for roughly 80% of the short distance goods movement, defined as 250 miles or less. They further estimate that about half the weight of these goods and 40% of the volume is moved over relatively short distances of 100 miles or less between the origin and destination.

While these vehicles act as the foundation for economic activity, their high emissions argue for a to transition to new, cleaner, more efficient vehicles and fuels. Despite the economic importance of this sector, little is known about the way medium- and heavy-duty fleets move through truck turnover from initial acquisition to final disposition. Vehicle acquisition in commercial fleets differs significantly from that of private consumers as the vehicles tend to be acquired as a specialized tool to help perform a specific job rather than general purpose vehicles. Truck turnover involves many different actors in addition to the truck fleets including truck manufacturers, equipment and trailer distributors, upfitters, etc. (Birky *et al.*, 2017), dealers, leasing and rental companies, financial institutions, auction houses, and private sales.

Over the last decade, fuel consumption regulations for medium- and heavy-duty vehicles (MHDV) have tightened, and research and development efforts to decrease their emissions have increased significantly. Despite regulations and research, MHDV technologies lack the maturity of analogous technologies in light duty vehicles (Birky *et al.*, 2017). In 2011, the EPA and National Highway Traffic Safety Administration (NHTSA) joined forces on behalf of the Department of Transportation (DOT), to establish a comprehensive Heavy-Duty National Program aimed at reducing greenhouse gas (GHG) emissions and fuel consumption for on-road heavy-duty vehicles. More recently, in June 2020, the Advanced Clean Truck rule was approved by the California Air Resources Board (CARB), establishing a timeline for medium- and heavy-duty truck manufacturers to increase their sales of zero emission vehicles, with the goal of reaching 100% zero emission medium- and heavy-duty trucks by 2045 and zero emission drayage trucks by 2035, where feasible (California Air Resources Board, 2019). This manufacturing regulation is intended to help increase the supply of these vehicles that are available, which will be important for helping meet the goals outlined in Executive Order N-79-20. This executive order calls for reaching 100% sales of zero emission heavy-duty drayage trucks by 2035 and other medium- and heavy-duty trucks by 2045where feasible (Newsom, 2020). Subsequent to the completion of data collection for this project, CARB passed the Advanced Clean Fleets regulation requiring large truck fleets to purchase zero emission trucks (California Air Resources Board, 2023).

In addition to regulations, there are also many incentive programs to support the transition to newer, lower emission vehicles and cleaner fuels and technologies. At the federal level, programs like the Diesel Emissions Reduction Act and the Congestion Mitigation and Air Quality Improvement Program provide support for fleets. California also has many programs to support emissions reductions in fleets operating in the state including the Hybrid and Zero emission Truck and Bus Voucher Incentive Program (*Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)*, 2022), which provides a point of sale incentive of up to $300,000 towards the purchase of low carbon trucks and buses, and The Carl Moyer Program (California Air Resources Board, 2022) which provides up to $165,000 in rebates towards the purchase of a new heavy-duty vehicle and up to $40,000 for the purchase of a new medium-duty vehicle.

Fleet characteristics

Fleets ranging in size from one truck to two million trucks are owned and operated by private companies and public agencies. Fleets may be composed of everything from standard box trucks to specialized equipment such as forklifts or bucket trucks, used in a variety of applications. The size of an organization and the size of the fleet are not perfectly correlated. According to Nesbitt & Sperling (2001),

> *"There is no widely recognized definition of a 'vehicle fleet' or an accurate accounting of the number of vehicles residing in fleets."*

Commercial fleets are diverse, composed of a variety of vehicles and equipment (both on and off-road) that are used in an array of applications (Birky *et al.*, 2017). Fleets have been categorized based on vehicle application and vehicle type, vehicle number, or service provided (Bobit, annual; Miau et al., 1992; Shonka, 1980). According to Nesbitt & Sperling (2001),

> *"…typical (overlapping) fleet categories are based on vehicle function (emergency services, delivery vehicles, service vehicles, rentals) organization type (government, business), fleet size (total number of vehicles), and vehicle type (light-duty vehicles, trucks)."*

Seldom are fleets categorized based on geography. Companies operating several trucks from one location and others operating a few trucks each from many locations across multiple states may all refer to themselves as having a single fleet.

MDHD trucks are categorized into Gross Vehicle Weight Rating (GVWR) classes ranging from Class 2b (8,501 to 10,000 lbs.) to Class 8 (greater than 33,001 lbs.). (Nadel and Huether, 2020) report class 2b trucks accounts for about 58% of retail medium plus heavy-duty truck sales, followed by Class 3 (16%) and Class 8 (14%) while classes 4 through 7 combined account for about 12%. In contrast, (Nadel and Huether, *ibid*) report most of all fuel consumed by Class 2b through 8 trucks combined is consumed by Class 8 trucks (85%) while despite their very high numbers, class 2b trucks account for only 13%; the remaining 2% is consumed by passenger buses. In general Class 3-6 trucks are used for shorter trips than are Class 7-8 trucks: more than three-fourths (77%) of trips by Class 3-6 trucks are 50 miles or shorter, while more than two-thirds (69%) of trips by Class 7 and 8 are 100 miles or longer.

Organization Structures

The fleet's role within an organization also varies. Fleets can be tasked with a particular aspect of the business such as moving that company's products. Alternatively, moving other companies' products may comprise the entire business, i.e., for-hire. Some fleets do both, even in the same truck. Fleet management tasks including acquisition and retirement may be assigned to one person in a full-time capacity, as part of one person's responsibilities, or spread over multiple people. Given this variability, those who may be considered part of the fleet management team may be from one or more departments or areas within the organization including administration, finance, sales, operations, logistics, and optimization. These varied positions held by people with arguably different backgrounds, skill sets, and goals translate to different turnover decisions (Nesbitt & Sperling 2001).

Truck configurations

Even more than light-duty vehicles, medium- and heavy-duty vehicles are highly customizable, thus any given configuration may be produced in small quantities (Birky et al. 2017). As the National Research Council (2010) describes, different components of trucks including the tractor and trailer may be manufactured by completely different entities. It is not uncommon for manufacturers to produce an incomplete vehicle chassis or for body builders to not specify the power train or chassis (Birky et al. 2017; NRC 2010), leaving these to the buyer. Custom builds can range from medium-duty box trucks outfitted for long-haul applications to highly specialized cryogenic tanks, utility vehicles with lifts, and myriad other possibilities. Further, NRC (2010) emphasizes, "a given tractor may pull hundreds of different trailers of different configurations over its life."

Business cycle (expansion/contraction) impacts on fleet turnover

Nesbitt & Sperling (2001) describe how fleet size may expand or contract in response to new regulations and incentives whether to satisfy or circumvent such directives (Nesbitt and Sperling, 2001). Each such occasion is an opportunity for change to occur in established truck acquisition and retirement practices that may have become standardized during a period of stability in fleet size. Fleet composition, e.g., truck size, truck type, and ratio of leasing to owning also varies in part because of economic and tax reforms (Chaudier, 1989). In addition, fleets may break (what they manage as) one fleet into several smaller fleets, or consolidate several fleets into one central fleet if business conditions favor one or the other.

Conventional Truck Purchasing

Total Cost of Ownership (TCO)

The total cost of ownership (TCO) is a metric intended to quantify the cost to own and operate a vehicle throughout its life. TCO may be used to compare similar vehicles from different manufacturers or different vehicle technologies such as a diesel delivery truck to a battery electric delivery truck. The TCO calculation is widely discussed and used in studies of fleet purchasing. As evidenced by the literature, there is no single, agreed upon method for calculating TCO. Calculations range from summing a few costs such as capital, fuel, and maintenance costs to far more complex models including factors such as social benefits, e.g., emissions reductions, financing costs, i.e., interest rates, and public image. In a study of Zero Emission Freight feasibility conducted by the Hewlett Foundation (2020), the TCOs of seven different data sources was analyzed. They found each TCO varied in their method, but all consider some form of initial acquisition costs, operating costs (fuel and maintenance), charging infrastructure costs, resale value, and other factors such as time (for longer fueling times compared to gasoline- or diesel-fueled trucks) or weight penalties (for example, to account for added weight of batteries) for alternative fuel vehicles. In addition to these factors, the North American Council on Fuel Economy's (NACFE) online TCO calculator for medium- duty electric trucks includes factors such as the vehicle's duty cycle, incentives, battery life, taxes, changes in brand image, and cost differences for vehicles purchased versus leased (NACFE, 2018).

Furthermore, each component of a TCO calculation includes a level of uncertainty—whether the analysis explicitly includes it or not. This is especially true for vehicles incorporating new technologies. For example, NACFE notes that while resale and scrappage values have a significant effect on TCO calculations, the true effects are often unknown at the time of truck acquisition and are not guaranteed (Mihelic and Roeth, 2018). Furthermore, the use of incentives for the purchase of newer, cleaner vehicles are often highly influential in the TCO calculations. However, knowing the value of these incentives in advance often presents a challenge as some incentive programs provide awards only after the vehicle has been purchased. A study conducted by Di Filippo *et al.* (2019) demonstrates the significant impact of this variable. After running three separate scenarios for drayage truck purchases for the San Pedro Bay Ports (the Ports of Los Angeles and Long Beach), they found that the TCO of the average drayage truck could vary by as much as $483,000 depending on which incentives are applied and which electric utility is used for charging trucks. For example, the TCO for a drayage truck operating in Southern California Edison territory could vary between $258,000 and $676,000 depending on whether subsidies are applied. Meanwhile, the TCO for a drayage truck operating in Los Angeles Department of Water and Power's territory is estimated to cost between $341,000 and $736,000 depending on whether subsidies are applied.

NACFE further breaks down the components of a TCO calculation into two categories: hard or direct costs, and soft or indirect costs (Mihelic and Roeth, 2018; NACFE, 2018). Examples of hard costs include purchase, fuel, and maintenance costs while soft costs include training, compliance reporting, and legal liability. While the soft costs are not always directly associated with an individual vehicle, their cumulative effects can have a significant impact on the fleet's expenditures. Hard costs are direct monetary costs associated with the vehicle purchase and are therefore far more likely to be included in TCO calculations. In contrast, soft costs are far less tangible, so they are often overlooked by fleets.

TCO calculations are made more complicated than simple summing by approaches and concepts such as net present value, internal rate of return, discounting, and equivalent annual costs. One of the most common uses of TCO calculations is to find the return on investment to understand whether purchasing a vehicle with a higher purchase price but lower operating costs over time will pay off in the long run compared to another truck with a lower purchase price but higher operating costs (NACFE, 2018).

A recent meta-study by (Burke *et al.*, 2022) reviewed several TCO studies, including (Di Filippo *et al.*, 2019; Hall and Lutsey, 2019; ICF, 2019; Burnham *et al.*, 2021; California Air Resources Board, 2021c; Hunter *et al.*, 2021; Phadke *et al.*, 2021; California HVIP, 2022). The reviewed studies used similar methodologies for their calculations, but inputs, such as capital cost, maintenance costs, fuel costs, payback timeframe, depreciation, and resale value, varied from study to study. Even with this variation in the TCO inputs, the conclusions across the cited studies were similar with respect to a comparison of conventionally fueled and electric trucks: in at least some applications, battery electric trucks were expected to be competitive on a TCO-basis in 2025 and broadly cost competitive by 2030.

While decision processes may differ with each truck acquisition, (Mihelic and Roeth, 2018; Hewlett Foundation, 2020; Springer *et al.*, 2020) argue TCO is reported to be one of the main factors involved in fleet decision making. Springer *et al*. (2020) reports fleets require any new vehicle or technology acquisition be competitive on an overall TCO basis to be considered for use (Springer *et al.*, 2020).

Some fleets choose to prioritize certain costs over others rather than using a TCO calculation. A 2012 ICCT (2017) survey of fleets in the European Union found that more than 60% of fleets viewed fuel efficiency as the first or second most important criteria for truck purchasing. As fuel prices become more expensive, fleets are found to turn first to more efficient powertrains to help cut costs before turning to alternative fuel sources (Askin *et al.*, 2015). One study found that the median percentage of total operating costs spent on fuel for all fleets was 24% although fuel costs constitute a decreasing share of operating costs as fleet size increases (Schoettle, Sivak and Tunnell, 2016).

Even if more fuel-efficient technologies reduce TCO, there can be other barriers preventing fleets from acquiring more fuel-efficient trucks. Given the previously noted variability in the precise specification of truck drivetrains, body styles, and other elements affecting on-road fuel efficiency, fleets often are unable to get reliable information for their precise desired specification thus there is greater uncertainty about the future fuel costs of new technologies making it difficult for fleets to conduct a TCO analysis. Finally, a favorable TCO may not prompt the lower cost behavior because the person in an organization who pays the higher upfront acquisition costs may not be the one reaping the benefits of future operating cost savings (U.S. EPA, 2016).

Whether or not a (hypothetical) TCO) could change truck acquisition behavior, there may be capital constraints preventing the uptake of an initially more expensive truck. Many drayage fleets are operated by smaller companies who typically acquire used trucks. A study by the San Pedro Bay Ports found that drayage truck drivers choose to replace their older vehicles with cleaner vehicles to avoid paying fees imposed on older vehicles (Port of Long Beach and Port of Los Angeles, 2020). However, to meet these port-imposed emissions requirements, drayage operators were more likely to do just enough to stay ahead of the regulations, i.e., to replace their old trucks with a newer truck with which they were already familiar and which had a low cost differential from their past truck acquisitions. They also reported the importance of financing for these truck purchases as many independent owner-operators have difficulties accessing loans, and therefore cannot afford the higher upfront costs of purchasing a cleaner vehicle (Port of Long Beach and Port of Los Angeles, 2020).

Turnover Cycles

While there is a wide variation in the service time for medium- and heavy-duty truck fleets, estimates in the literature indicate on average large for-hire fleets operate trucks for 5.5 years while private (not for-hire) fleets operate trucks an average of 9 years before selling it to a secondary user (Sharpe, 2017; Nadel and Junga, 2020). Estimates of truck lifespans vary greatly by truck application. The American Transportation Research Institute (2016) estimates straight trucks have an average lifespan of 10 years while tractor-trailers have an average lifespan of 7 years. Schoettle, Sivak and Tunnell (2016) state that in general, larger fleets turn their vehicles over within the first three to five years of operation, much sooner than smaller fleets. Truck life also varies by application: regional haul fleets tending to keep their vehicles for much longer than long haul fleets (Nadel and Junga, 2020). The shorter average lifetime of the long-haul trucks means they have a disproportionately larger share of annual sales (Birky *et al.*, 2017). Medium-duty trucks are often kept much longer with many fleets depreciating the expected costs of the vehicles over 10 years and often keep them up to 20 years (NACFE, 2018). Medium-duty trucks may be kept for their entire useful lifetime, so any residual value is their salvage value. In some cases, components of the vehicle can then be sold for second use in off-road equipment such as agricultural uses. In other cases, these vehicles are scrapped.

Schoettle, Sivak and Tunnell (2016) further note trailers purchased by fleets are typically kept for a longer period than are tractors, giving trailers much different purchase-retirement cycles. They report on average trailers are kept for 12 years while tractors are kept an average of 7 years.

Truck replacement timelines differ between fleets that replace trucks at an established age or mileage threshold versus those that replace trucks once the cost to repair them exceeds a specified limit. A common cost criterion is when a truck’s actual or expected maintenance and repair costs exceed the residual market value of the vehicle, effectively making it more expensive to repair the vehicle than to sell it (Bibona, 2015). This calculation helps determine when the fleet should replace a truck to achieve the lowest TCO of the vehicle over its economic life cycle. The use of this replacement method is limited as it requires a large amount of data on each vehicle as well as the use of complicated economic analyses. Using this method also creates a dynamic TCO scenario as the truck is not replaced at a standard time. This requirement makes it more common for fleets to use specific mileage or age thresholds as an approximation for when vehicles are expected to cross this “lowest lifetime cost” threshold (Bibona, 2015).

Further complicating the replacement cycles, many medium- and heavy-duty vehicles are customized, perhaps by one or more third parties. For example, utility vehicles often begin with truck manufacturers who build the vehicle chassis, which is then sent to a truck body manufacturer, who builds on specialized equipment customized toa fleet’s needs (Birky *et al.*, 2017). The equipment and trailer distributors then integrate these pieces and sell the vehicles to the fleets. While such customization may increase the value of the truck to the first buyer, it may limit the value of the truck in the resale market as there may be many fewer potential second buyers for that same custom equipment.

Fuel Cost: Operational Changes vs. Capital Expenditure

Certain operational procedures can increase on-road truck efficiency, reducing operating costs and thus changing truck acquisition and retirement decisions which depend on operating costs. According to Sharpe (2017), fleets often reported they believed operational improvements to be far more cost effective than purchasing efficiency improving technologies. These operational procedures include optimizing routes, sharing trucks and warehouses, shifting to more efficient modes of transportation, limiting truck speed, and changing driver behaviors (Askin *et al.*, 2015; Moultak, Lutsey, and Dale, 2017). The literature acknowledges the difficulties associated with trying to increase efficiency through driver behavior as drivers are often not financially rewarded by their companies for fuel efficient driving behaviors (Sharpe, 2017).

Fuel Cost: Fuel Saving Technologies

Fuel is typically the second largest cost component for an ICE truck after labor cost (Springer *et al.*, 2020). According to the State of Sustainable Fleets 2020 report, 39% of fleets are utilizing technologies to improve vehicle efficiency either within pilot or general fleet operations. They Class 8 tractors are the most likely to be acquired with fuel efficiency enhancing technology. This is likely attributable to the fact fuel costs are an even greater expense for Class 8 trucks in high mileage applications.

There are a variety of fuel saving technologies available including side skirts, low rolling resistance tires, and idle reduction technologies. Schoettle, Sivak and Tunnell (2016)examined fuel economy and fuel usage in heavy duty truck fleets. They found the most common truck-based technologies are aluminum wheels (90.4%), speed limiters (84.0%), and low rolling resistance tires (76.1%). This study also reported the technologies with the quickest returns on investment were aerodynamic treatments, idle reduction technologies, and automatic transmissions).

Achieving a quick return on investment or a certain payback period when making investments in technologies to improve fuel efficiency has been reported to be important to fleets (Schoettle, Sivak and Tunnell, 2016; U.S. EPA, 2016; Sharpe, 2017; Mihelic and Roeth, 2018). Schoettle, Sivak and Tunnell (2016) report that smaller fleets (those with 20 or fewer vehicles) required the shortest payback period (median = 12 months), while the median for all fleets was approximatly 24 months. This result is supported by Sharpe (2017), who notes fleets generally expect to see a payback period of 2 to 3 years for energy efficient technologies. Future fuel cost savings are often difficult to predict, which makes many fleets hesitant to make upfront expenditures in fuel saving technologies (U.S. EPA, 2016). According to Sharpe (2017) and Springer *et al.*, (2020), few fleets believe such technologies will be cost effective and may result in higher maintenance costs and slower acceleration.

Sharpe (2017) identified four main types of barriers to adoption of fuel saving technologies: uncertainty about their performance and cost savings, capital cost constraints, split incentives, and a poor technology availability. Heavy duty vehicle buyers have reported being unable to obtain reliable information on the effectiveness of fuel savings, reliability, and maintenance costs of these technologies (U.S. EPA, 2016). Where information on fuel saving technologies is available, it is often not clear about the differences between effects for different operating profiles (Sharpe, 2017). This problem is partially attributable to fuel consumption being dependent on many different variables such that the effect of these technologies will vary greatly between trucks depending on characteristics such as truck class, intensity of use, typical distance of trips, driver characteristics, road conditions, regional geography, and traffic patterns (Sharpe, 2017). Fleets often face low operating margins and are risk averse so they will avoid investing in new technologies and guard against potential negative impacts (Hewlett Foundation, 2020). The lack of specifically applicable information makes it difficult for fleets to understand how the technology will affect their fleet and their fuel expenditures, leading them to report being more comfortable when they are able to test new technologies on a few of their own vehicles before considering a broader deployment (Sharpe, 2017). If fleets are unable to test the technologies themselves, they often rely on information from other fleets with characteristics like their own (U.S. EPA, 2016). While the literature generally states that fleets prefer to try these new technologies before implementing them, the 2020 State of Sustainable Fleets (Springer *et al.*, 2020) found that over 80% of fleets who acquired these technologies did so without first having conducted a pilot demonstration with them.

The upfront capital costs of these technologies also pose a barrier when fleets are unable or unwilling to invest the capital to make the purchase, even if they know that the technology is cost effective over its lifetime (Sharpe, 2017). One of the major driving factors is the principal-agent problem in which the person who pays the upfront cost of the new technology is not the one who benefits from the fuel savings it creates (U.S. EPA, 2016). This issue is more present in larger fleets with a purchasing department who pays the capital costs of the vehicle while the user departments pay fuel costs; thus, the purchaser is shielded from the benefits and sees only the costs. This issue is especially prevalent in the drayage industry where there is a large reliance on independent contractors (Di Filippo *et al.*, 2019). Additionally, in some cases fuel expenses are paid for by the business who is contracting for the shipment, and not the fleet itself, creating little incentive for the fleet itself to invest in fuel saving technologies (Sharpe, 2017).

Technology adoption is also influenced by the degree to which a product requires a change in behavior (Mihelic and Roeth, 2018). If the technology requires the operator to change how they interact with the vehicle, they are less likely to use it than a technology that, once integrated, requires little to no changes. One reason for this is technologies requiring a change in operator behavior may also require training drivers, mechanics, and others (U.S. EPA, 2016). U.S. EPA (2016) reports fleets operating heavy-duty trucks are less likely to acquire a technology if it is not available from their preferred manufacturer, even if it would result in fuel savings. In some cases, maintenance departments have been built around specific vehicle manufacturers (and even specific vehicles), so switching to another manufacturer would entail additional costs to retool and retrain. In the U.S., fleets face high rates of driver turnover so businesses are often concerned that drivers may not accept the new equipment, which may prevent new technologies from being acquired (U.S. EPA, 2016; Sharpe, 2017).

Used Vehicle Purchasing

There may be a larger knowledge gap among used truck buyers than new truck buyers regarding the value of fuel cost savings compared to upfront purchase price which may cause used truck buyers to be slower in adopting fuel saving technologies (U.S. EPA, 2016). This effect is seen in a study of the San Pedro Bay Port (Di Filippo *et al.*, 2019) which found that the Clean Trucks Program implemented at the port limited drivers' ability to purchase used vehicles by raising their purchase costs. In some cases, licensed motor carriers were able to purchase these trucks and then offer them to independent truck drivers on a lease to own basis. This strategy placed these companies in charge of making the decision on which trucks to purchase, removing that choice from the contractors.

Drayage fleets generally operate on narrow margins and pay drivers low wages, leading them to minimize purchase costs with used truck purchases. Drayage fleets buy a large share of their trucks as used (Di Filippo et al, 2019). In part this is because the trip and daily total distances over which drayage trucks travel is much less than long-haul or regional-haul applications. A study of the San Pedro Bay Ports (Port of Los Angeles and Port of Long Beach) conducted by the University of California, Los Angeles found that between 2013 and 2018, only 30% of trucks added to the port registries were purchased new and that the average age of a newly added truck was 2.5 years (Di Filippo *et al.*, 2019). About half of the trucks added to the registry over this time were at least 3 years old. Used vehicles must be given special consideration as the technology and emissions of these vehicles lags significantly behind that of new trucks.

Alternative Fuels

Alternative Diesel Fuels

Diesel and gasoline are the standard fuels for MHD vehicles. Compared to presently available alternative fuel options including electric, these standard fuels allow rapid fueling, long driving range, ubiquitous supply, low upfront costs, and low vehicle weight (Springer *et al.*, 2020). Alternative fuel and advanced gasoline and diesel technologies are promoted as means to achieve environmental and sustainability goals. As commercial truck fleets are diverse (in size, vehicle type, organizational structure, operating territory, application, etc.), no alternative fuel solution has yet been found to fit them all (Birky *et al.*, 2017; NACFE, 2018). Alternative fuels technologies differ in their readiness for broad application. Fleets willing to accept the risk of new technologies may play an important role in helping manufacturers and technology developers understand how to meet fleet requirements.

Springer et al. (2020) report fleets are more likely to use alternatives to diesel fuels when the alternatives are drop-in replacements, such as renewable diesel and biodiesel (Springer *et al.*, 2020). Further, if diesel engines can improve and meet more stringent low NOx standards, fleets may prefer to continue purchasing and deploying conventional diesel vehicles. The State of Sustainable Fleets (Springer *et al.*, 2020) found that amongst early-adopter fleets who have begun deploying these alternative fuels, sustainability was reported to be the most important motivating factor (Springer *et al.*, 2020). Notably, none of these fleets report motivations such as reduced cost, improved performance, and ready availability as motivations. Still, Springer *et al.*, (2020) report 98% of respondents who are currently using the technologies expect to continue to do so in the future.

There are a variety of gasoline and diesel alternatives fleets can use in their current vehicles. One example is renewable diesel, a biofuel derived from biomass materials (US EIA, 2022). Renewable diesel is a drop-in fuel, meaning it has the same chemical composition as petroleum-based diesel, allowing it to be blended into or serve as a complete replacement for conventional fossil diesel engines and infrastructure, requiring no significant hardware changes (Springer *et al.*, 2020). Renewable diesel also provides a significant reduction in costs to operate, maintain, and regenerate diesel particulate filters, creating additional cost savings for fleets. Renewable diesel is generally limited in availability: California and Oregon have the highest availability. The costs of production are significantly higher than conventional diesel, making the fuel price higher (Springer *et al.*, 2020).

Biodiesel is another diesel substitute for fossil diesel and is made from vegetable oils or animal fats. While biodiesel has a similar chemical composition to petroleum-based diesel, its physical properties differ slightly, e.g., it does not perform as strongly in cold weather. Therefore, biodiesel is generally blended into conventional diesel at 20% or less (Springer *et al.*, 2020). Regulations often require biodiesel to be blended in with conventional diesel, thus requiring no effort by fleets to use. The State of Sustainable Fleets (Springer *et al.*, 2020) reported fleets have mixed feelings about the performance of biodiesel, especially at higher blend concentrations and in colder climates as there is a greater risk of the fuel clogging the filters and traps. Schoettle, Sivak and Tunnell (2016) report the top three alternative fuels used by fleets were all biodiesel blends with the most common being a blend of 95 percent conventional diesel and five percent bio-diesel (B5) (49.4%), followed by B10 (39.0%) and B20 (24.0%).

Zero-Emission Trucks

California's Advanced Clean Trucks (ACT) regulation requires the sale of increasing shares of zero-emission trucks through 2035. Miller, Wang, and Fulton (2022) estimate diesel and gasoline vehicles will continue to dominate truck sales through 2030, however, zero-emission trucks are modeled to reach a 100% sales share between 2035 and 2040 in California and between 2045 and 2050 for the rest of the U.S.

Several studies have examined barriers or limitations to battery electric truck use including truck cost, driving range, charging infrastructure, charging times, vehicle weight, and limited availability of desired truck types (Schoettle, Sivak and Tunnell, 2016; Anderhofstadt and Spinler, 2019; Di Filippo *et al.*, 2019). An examination of factors affecting the adoption of electric trucks in Germany found high purchase price to be the top barrier to fleets transitioning from diesel to electric trucks. Beyond purchase price, uncertainties around electric truck residual value, maintenance costs, and the comparative prices of electricity, gasoline, and diesel reduced fleet decision-makers' confidence in electric trucks as potential fuel saving technologies. Uncertainty leads to complications in calculating the total cost of ownership of electric trucks. Studies report the high importance fleets place on fuel costs, which make up a large share of the fleet's annual costs. Despite this uncertainty, companies who use a TCO analysis were the most likely to purchase an electric truck.

Low driving ranges of electric trucks in comparison to diesel trucks were also reported as a main barrier by (Schoettle, Sivak and Tunnell, 2016 and Anderhofstadt and Spinler, 2019). Fleet decision-makers and drivers prefer trucks with the maximum possible range so they can make the greatest number of possible trips during a shift, thus maximizing their profits (Di Filippo *et al.*, 2019). Range concerns were reportedly perpetuated by the lack of publicly available charging points and the lack of standardized charging plugs. Charging infrastructure concerns extended to the length of time required to charge battery electric trucks. Fleets reported charging times to be too long, which would not fit with their operating schedules.

Studies additionally show that electric trucks have decreased payload capacities due to increased unladen truck weight created by the battery pack (Hewlett Foundation, 2020). While battery manufacturers are working to reduce weight, the rapid advancement in battery and electric truck technology led participants in one study to view the acquisition of an electric truck with current technology as a disadvantage (Anderhofstadt and Spinler, 2019).

While some fleets may look for alternative fuel trucks to have a total cost of ownership less than or equal to that of diesel trucks, alternative fuel trucks may have added features (monetary and non-monetary) which should also be accounted for in these calculations. In Germany, participants reported their decisions to acquire heavy-duty electric trucks as being driven by the ability to enter low-emission zones, reduced emissions, and reduced noise levels (Anderhofstadt and Spinler, 2019). These factors were especially important for trucks used in urban logistics. The comparatively low maintenance costs of battery electric trucks compared to diesel trucks can serve as a motivation for electric truck acquisition (Di Filippo *et al.*, 2019). The lower fueling costs and reduced emissions are the most advantageous features of electric trucks in comparison to diesel trucks (Schoettle, Sivak and Tunnell, 2016).

Compliance, Policies, and Mandates

At present, the push towards cleaner trucks comes from regulations. These provide investment certainty for technology developers while ensuring fleets have a suite of technologies from which to choose. Sharpe (2017) reports heavy duty truck fuel consumption decreased by about one percent per year between 1970 and 2010, far slower than the two to four percent annual increase some regulatory programs now require. Clean trucks are supported through a variety of policies, e.g., fuel efficiency standards and fiscal measures. Fiscal policies include taxes and fees for less efficient equipment or financial incentives for cleaner technologies through feebates, grants, vouchers, carbon taxes, etc. These programs help address the split incentives issues as well as capital cost constraints and can help fleets invest in technologies that they would otherwise not be able to due to cost constraints (Sharpe, 2017). Other policies that can encourage the adoption of cleaner truck technologies include diesel bans and clean air zones that limit the types of vehicles that can enter regions (Hewlett Foundation, 2020).

Sharpe (2017) argues policies and programs can and should continue to provide standardized information on the efficiency and performance impact of efficiency technologies and alternative fuel vehicles. Lack of information has been reported to be one of the main barriers to the adoption of clean trucks. The Hewlett Foundation (2020) argues that standardizing and improving the quality of information about clean truck technologies' costs and benefits are crucial. Information on the technological readiness of technologies, their total cost of ownership, and potential non-monetary benefits are needed (Hewlett Foundation, 2020). Education may make these technologies feel more approachable to fleet decision makers. Education campaigns should also include outreach and technical assistance programs to help companies and independent drivers acquire clean truck technologies (Di Filippo *et al.*, 2019).

At present, electric truck technologies have higher upfront costs than existing trucks. Some fleets, perhaps especially small fleets and independent truck drivers may not be able to afford these higher costs and financers may be reluctant to provide the necessary increased credit. Financial institutions can be encouraged to incorporate climate and health risks into the equity calculations to help incentivize cleaner trucks over more polluting ones (Hewlett Foundation, 2020). While grant and incentive programs can help defray upfront costs, demand for these programs has often outstripped the funding allocated to them (Di Filippo *et al.*, 2019).

The Hewlett Foundation (2020) argues policy measures for zero emission trucks may be important for California to achieve its goal of all zero emission trucks on the road by 2045. This government support will be required for the wide scale deployment of zero emission truck fueling, especially for long haul trucks which require infrastructure to be deployed along trucking corridors. They also discussed the weight barriers associated with zero emissions trucks, calling for exemptions to these limits.

Within each of these policies, consideration must be given to achieving a balance between pushing for the development of cleaner technologies and ensuring that they are proven to work in each application (Port of Long Beach and Port of Los Angeles, 2020). Care must also be taken to ensure that the costs of transitioning to cleaner trucks is not overly burdensome for both large fleets and independent owner-operators. Incentives to accelerate the retirement of trucks must account for the residual value of the retired vehicle in addition to the incremental costs of the cleaner technology. This may be especially true in cases where an older truck must be retired from service rather than sold into the secondary market. Programs that promote truck turnover are more cost effective than those that force the purchase of new trucks (Port of Long Beach and Port of Los Angeles, 2020).

Summary

The literature on medium- and heavy-duty truck turnover indicates there is significant variation in how fleets acquire and retire vehicles. Decision making is influenced by the fleets' organizational structure, truck applications, and fleet type. Trucks are highly customizable and are utilized in diverse ways. There exists a broad range of factors influencing turnover decisions, and individual fleets vary in which factors they consider important and how those factors are used.

The literature contains significant discussion of the total cost of ownership and describes a wide variation in the components of and procedure to calculate this factor. Turnover cycles and truck service time differ based on fleet size and application. Regulations can have a large effect on both truck acquisition and retirement. Fleets consider the increased taxes and fees for owning less efficient equipment and potential financial incentives for cleaner technologies when making turnover decisions. California's recent regulations require a transition from the present fossil fueled trucks to zero emission vehicles. This transition presents fleets with several benefits such as the ability to enter low-emission zones, reduced noise levels, low maintenance costs, and lower fueling costs, but barriers are extensive including truck cost, driving range, charging infrastructure, charging times, vehicle weight, and limited availability of desired truck types.

Task 2 Realized Sample

The sample of interviews conducted for Task 2 is described in Table 1. Note the counts in the table sum to more than the actual number of interviews (n = 99) since some fleets operate in more than one use case and manufacturers, dealers, leasing companies, auction and sales companies, advisors and consultants typically serve fleets across more than one use case. For example, a total of eight interviews have been conducted with dealers and manufacturers. All but one sell, lease, or rent trucks to fleets providing long-haul, short-haul, and drayage services and thus each of those three use cases shows seven interviews. These are the same seven interviews, i.e., they are not counted as (3 x 7 =) 21 interviews. Ninety-seven of 99 interviewees gave us permission to record their interview. Recorded interviews were transcribed. Of the 97 interviews with transcriptions, 88 had completed pre-questionnaires. (Interviewees who were not fleets, i.e., consultants and manufacturers, did not complete pre-questionnaires.) Irrespective of whether an interview is accompanied by a transcript and a pre-questionnaire, 89 fleet interview and nine manufacturer, consultant, and auctioneer interview summaries have been prepared and included in Appendix C. Because they provide second-hand supporting information about fleet decision making, summaries of interviews with manufacturers, dealers, consultants, and auction houses are not included in the Appendix.

Table 1 Realized Sample of Interviews by Organization Type and Use Case, counts

	Use Case				
	Heavy-Duty			Medium duty	
Organization Type	**Long Haul**	**Short Haul/ Delivery**	**Drayage**	**All**	**Total[1]**
Large Fleets (≥ 150 trucks)	13	15	1	10	25
Medium Fleets (21 to 149 trucks)	11	14	7	11	28
Small Fleets (1 to 20 trucks)	10	8	6	15	27
Manufacturers, Dealers	7	7	7	6	8
Advisors, Consultants	3	3	4	1	4

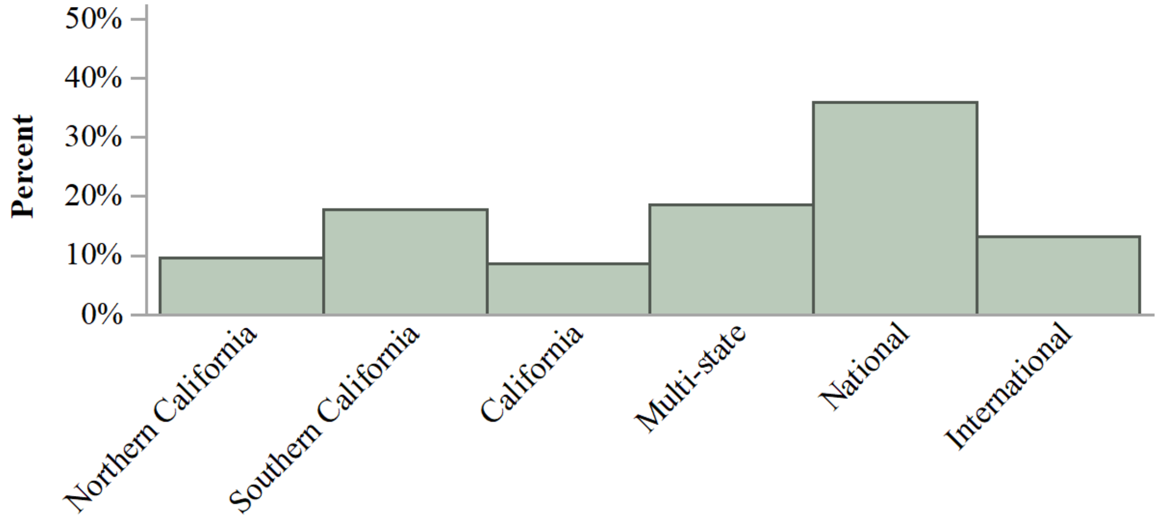
1. Rows add to more than the Total because any organization type may have multiple use cases.

Evidence of the success to contact potential interviewees with specific knowledge of fleets' decisions to acquire and retire medium- and heavy-duty trucks is provided by the high quality of the discussion recorded in the interviews and by the quantitative assessment made possible by the pre-interview questionnaires. The pre-interview questionnaire includes separate questions about the respondents' roles in acquiring and retiring trucks.

Other basic descriptors of the realized sample are illustrated in Figures 1 through 7. We emphasize the description is of the sample; no representation is made these data accurately describe the population of all entities operating medium- and heavy-duty vehicles in California. Sampling imposed neither prohibition on where in the United States the entity operating the fleet is headquartered nor proscription to only operate trucks in California.

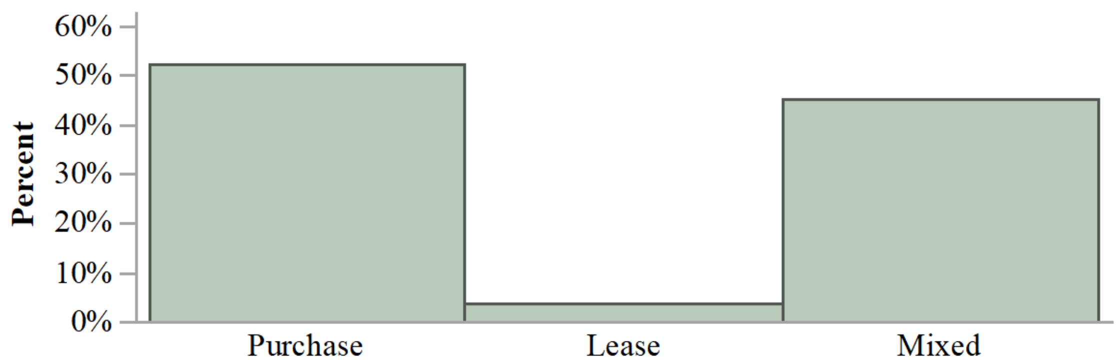
With these provisos, the largest region over which each entity operated their trucks is shown in Figure 1. The distinction between "multi-state" and "national" rests on whether the entity may operate in any state in the nation ("national") or operates within a specific set of states, e.g., a fleet operating only in California, Oregon, and Washington is "multi-state" rather than "national." "International" includes all fleets operating any truck outside the 50-US states regardless of their reach within the US. Thus, a fleet operating in southern California and northern Mexico is "International" not "Southern California."

Figure 1 Largest Region over which each Fleet Operates Trucks, percent



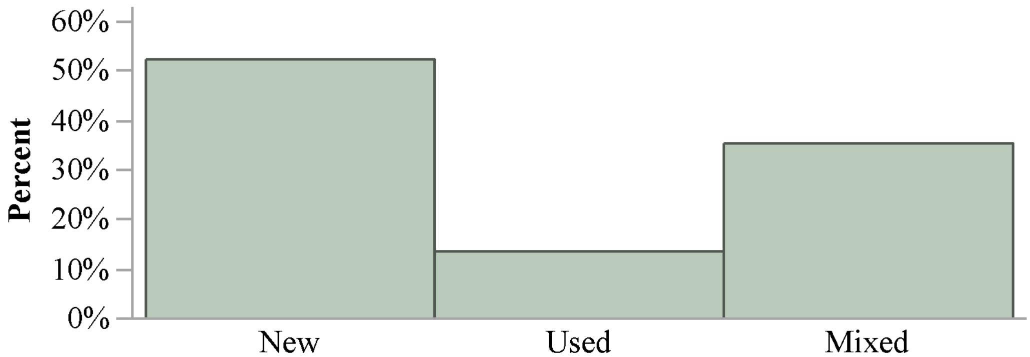
As seen in Figure 2, most fleets in the sample acquire trucks via purchase (or a mix of purchase, lease, and rent) and only a small minority acquire trucks via leasing only. However, very nearly half of fleets acquire at least some trucks via lease. While this snapshot of how fleets acquire trucks can't tell us whether leasing is increasing, reports from our interviewees—including large entities that lease trucks to fleets—are that of that the time of the interviews leasing was increasing as a percentage of all truck acquisitions.

Figure 2 How Fleets Acquire Trucks, percent



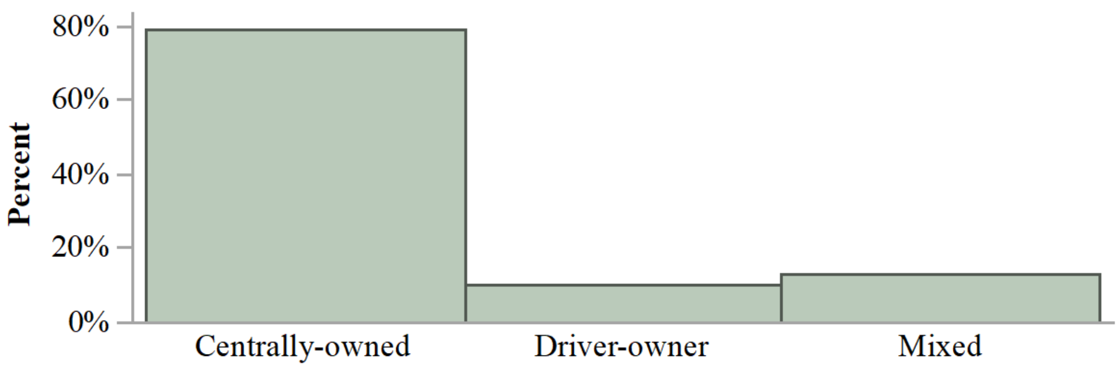
Most of the participating fleets acquire their trucks as new, whether solely as new or as new or used (Figure 3), though nearly half of fleets acquire at least some of their trucks as used.

Figure 3 Acquisition of New and Used Trucks, percent



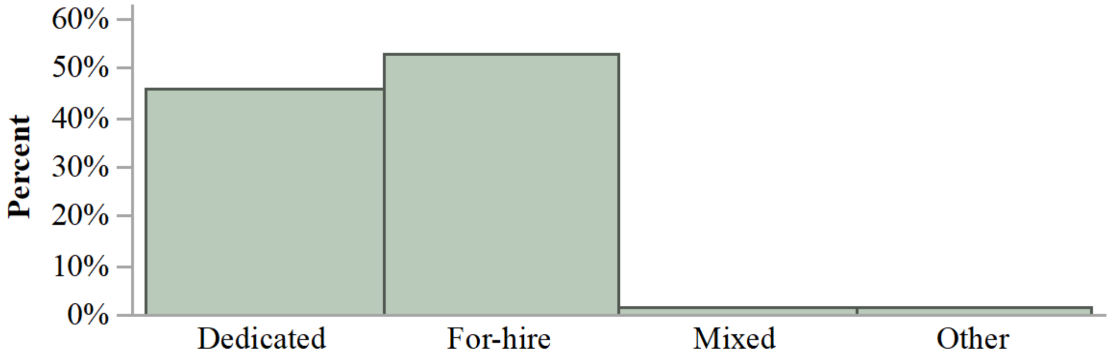
Truck ownership models describe who owns (or leases or rents) the trucks a fleet operates (Figure 4). Most of the sample fleets are centrally owned. While owner-operator is the other archetype of fleet ownership, there are as many fleets in this sample operating in a mixed mode in which some trucks are owned by the operating entity and driven by employee-drivers as other trucks are contracted with independent driver-owners.

Figure 4 Truck Ownership Models, percent



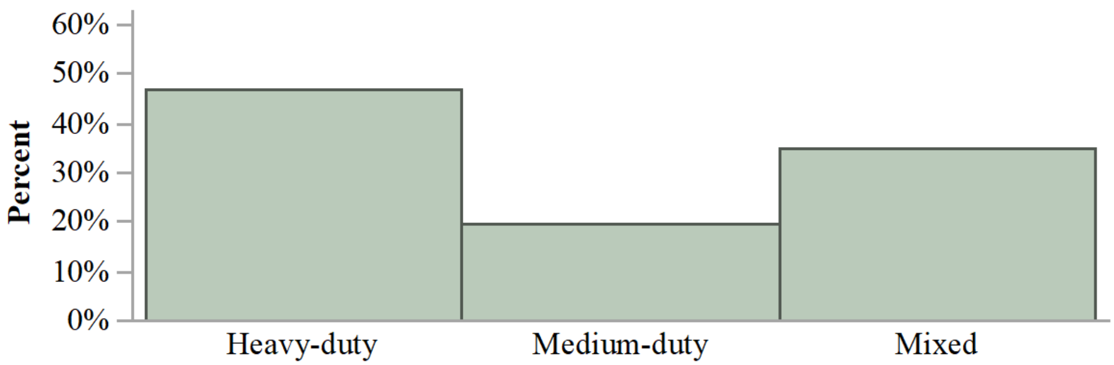
Distinct from ownership models, operating models describe whose freight is moved in the fleets' trucks (or more generally, whose work is accomplished via the use of the fleets' trucks). "Dedicated" fleets use their trucks to move their own products (or otherwise conduct their own business), e.g., a food or beverage company that operates their own trucks to move their food products or beverages from production facilities to points of sale. "For-hire" fleets transport freight for other businesses. Only two fleets in this sample don't neatly fit into one of these two categories. Slightly more than half the fleets in this sample are for-hire operators. The distribution of fleets by operating model is shown in Figure 5.

Figure 5 Fleet Operating Models, percent



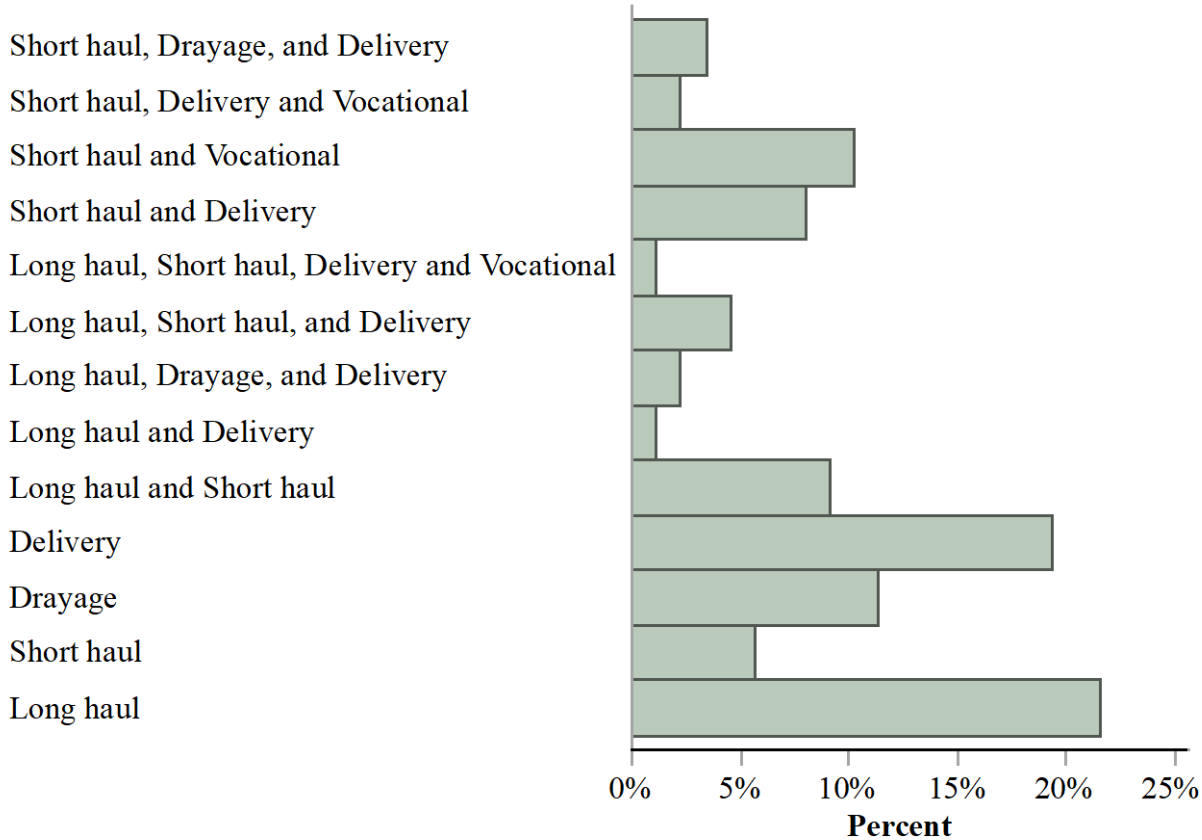
A plurality of these fleets operate only heavy-duty trucks (Class 7 or 8), but including fleets operating a mix of heavy-duty and medium duty trucks a large majority operate fleets that include at least some heavy-duty trucks (Figure 6). Fewer fleets operate only medium-duty trucks (Class 2b through 6) than operate mixed fleets of medium- and heavy-duty vehicles.

Figure 6 Presence of Medium- and Heavy-Duty Trucks, percent



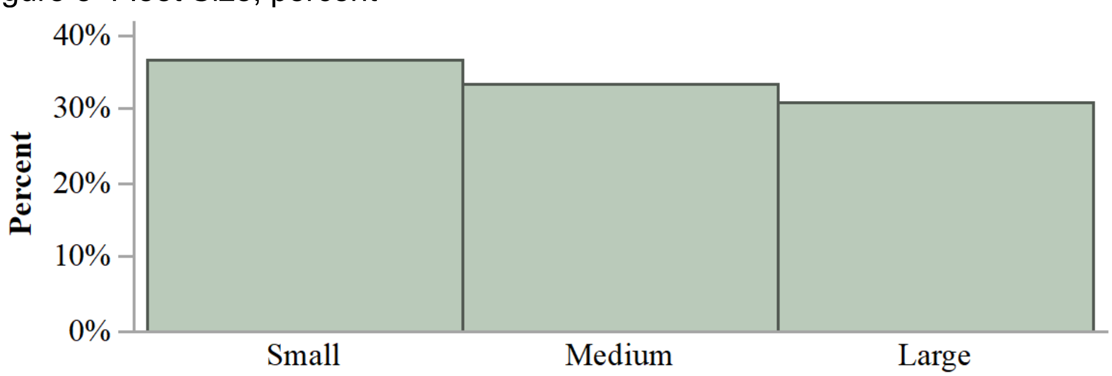
Use cases for trucks are classified here as Heavy-Duty: Long Haul, Short Haul, and Drayage as well as Medium-duty: Delivery and Vocational (Figure 7). “Long Haul” includes both long haul (typically involving a truck that doesn’t return to a central depot every day while transporting freight over long distances) and line haul (typically the movement of freight over long distances by multiple modes, including trucks). “Short Haul” includes the movement of freight over short distances, typically allowing the truck to return to a central depot every day. “Drayage” is also the movement of freight over short distances but is distinguished by the fact the origin or destination of the freight movement is a port. “Delivery” is the movement of freight over short distances via medium-duty trucks “Vocational” includes trucks supporting non-freight movements. Examples include vehicles used by trades contractors and service providers including mobile truck maintenance services. Vocational vehicles may be fitted with specialized equipment, e.g., utility trucks fitted with lift buckets or not. A plurality of fleets in this study (58 percent) are engaged exclusively in one of these general use classes. Conversely, many entities in this sample of fleets operating medium and heavy-duty trucks in California are operating across use cases either with only heavy-duty trucks, e.g., firms providing Short Haul and Drayage services, or a mix of medium and heavy-duty trucks. The most diverse fleet interviewed for this study is a large, national, electrical engineering firm whose fleet includes vehicles spanning from Class 1 light-duty cars and trucks through vehicles in most all heavier categories up to Class 8 tractor-trailer combinations.

Figure 7 Truck Use Cases, percent



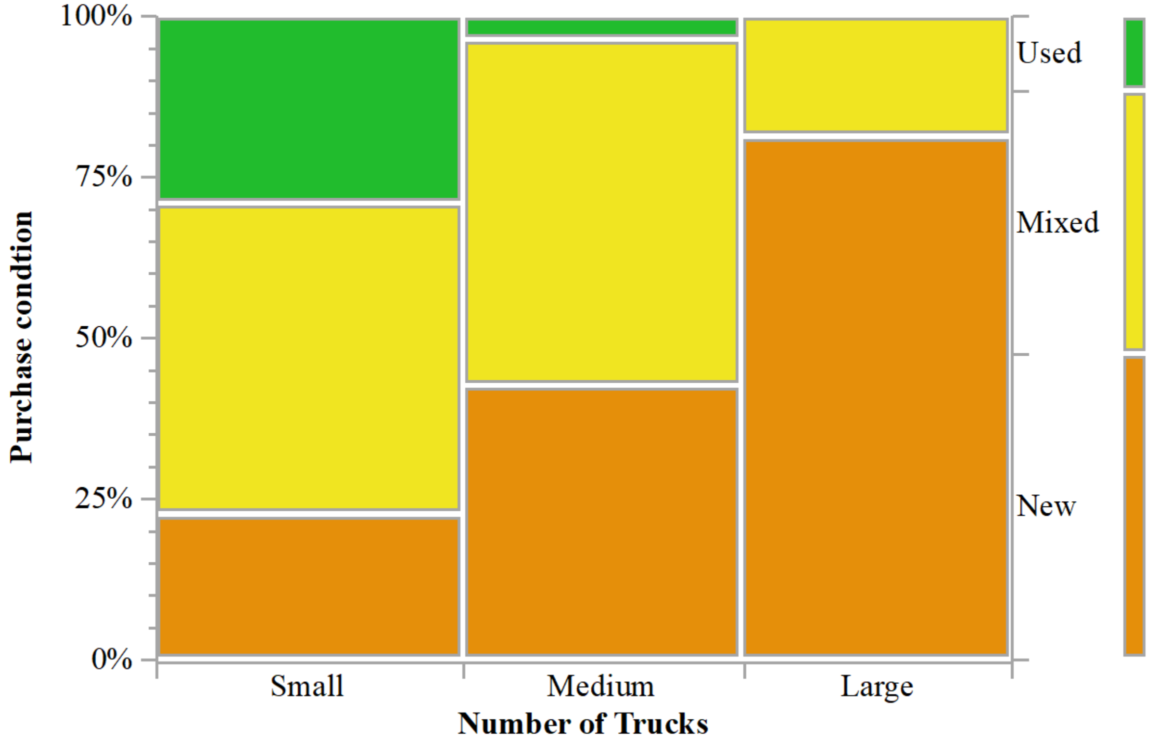
Finally, the sample may be described by the distribution of fleet size as counted by the number of vehicles rather than measures of revenue, employees, or geography. The sample is made up of nearly equal numbers of fleets in the categories Small (twenty or fewer trucks), Medium (21 to 149 trucks), and Large (more than 150 trucks).

Figure 8 Fleet Size, percent



As it may be related to the uptake of alternative fuel and electric trucks—since initially all alternative fuel and electric trucks must be acquired as new trucks—we illustrate the present distribution of gasoline- and diesel-powered trucks as new or used by the size of the fleet. The latter is a proxy measure of the resources available to the fleet. As seen in Figure 9, large fleets are overwhelmingly likely to acquire only new trucks while small fleets are overwhelmingly likely to acquire at least some used trucks. Ninety percent of participating fleets who acquire only used trucks are small fleets.

Figure 9 Truck Acquisition Condition by Fleet Size, percent



Task 3: Determinants of Medium and Heavy-Duty Truck Turnover

Here we list and describe the determinants of the participating fleets' medium and heavy-duty truck acquisition. Determinants are derived from the interview coding. The discussion of each determinant starts with the determinant name in **bold**.

Cost Accounting

The role of total cost of ownership (TCO) calculations in fleet turnover will be discussed further in the later section, "General Effects across Many Fleets." Here, we present some of the determinants that are commonly included in TCO models—whether fleets include them or even whether fleets treat some of these as monetary costs in their truck turnover decisions.

Fuel efficiency is something fleets can affect that would in turn affect their fuel cost (given their existing trucks and the available options to replace them) even if they can have little to no effect on fuel prices. Fuel expenditures are high for medium- and heavy-duty trucks and higher still given recent trends in gasoline and diesel prices. Despite this, fleets differ in their approach to using fuel efficiency in their truck acquisition decisions.

- To start, fuel efficiency is seldom reported as directly triggering either truck acquisition or retirement. Rather, it may affect which truck is acquired (retired) once an acquisition (retirement) decision has been made.

On the one hand, some fleets report there is little to nothing they can do to increase their on-road fuel efficiency. Some claim they have no information on the fuel efficiency of new (especially heavy-duty) trucks. Others claim they can't get their drivers to drive the more fuel-efficient vehicles, especially if fuel efficiency is achieved via lower top speeds (drivers tend to be paid by the mile, so faster is better) or reduced power. Others claim that once they have specified other "requirements" for their fleets, there is too little difference in fuel efficiency between trucks to worry about it.

In contrast, other fleets—some of which are operationally similar to fleets just described—insist that fuel is their largest cost component and—almost—anything they can do to increase fuel efficiency will quickly provide a monetary payoff. Some of these fleets have engaged with truck manufacturers to develop more fuel-efficient truck specifications and others experiment with aftermarket treatments, i.e., technologies that can be applied after a truck is acquired such as trailer skirts to improve aerodynamics. These fleets differ as to whether they incorporate driver behavior—or imagined driver behavior—in how far they are willing to push these specifications.

Maintenance affects truck turnover in most of the fleets interviewed for this study. However, how maintenance affects these decisions differs greatly between fleets.

- If a fleet conducts any sort of cost analysis that synthesizes multiple costs, maintenance costs are almost always included.
- Some fleets conduct periodic reviews, e.g., quarterly, to identify trucks for potential retirements.
- Rather than tracking ongoing costs, some fleets use one of a variety of heuristics related to maintenance.
    - The end of a warranty period may determine truck retirement or at least trigger a review.
    - Extended warranties may substitute for historical data if a fleet buys a truck brand with which it has no operating experience; when buying a familiar truck, the fleet would not buy an extended warranty.
    - Truck "age"—typically measured as total miles—may substitute entirely for maintenance cost. As a result of experience with trucks, i.e., not accounting for whether the relationship between, say miles and maintenance costs, may have changed with new generations of trucks, many fleets adopt simple rules for retiring trucks. Overall, these fleets—whether they keep an accounting of maintenance costs or not—base decisions to retire trucks based on truck age thresholds.
        - We observe these thresholds may be deployed in two ways:
            - when a truck reaches the threshold value it is retired, or
            - when a truck reaches the threshold value it is reviewed for retirement, pulling in other

information to inform the retirement decision.

- For fleets using a total-miles heuristic, these rules appear to vary by truck class and application.
  - Medium-duty trucks are reported to be subject to thresholds ranging from 150k to 200k miles.
  - Heavy-duty trucks are reported to be subject to thresholds ranging from 450k to 800k miles.
- Accounting for maintenance costs depends in part on how those costs are paid. In some fleets, maintenance is a separate cost item based on the expense of operating an in-house maintenance program or contracting maintenance to third parties. This is one difference that appears to be correlated to operational characteristics, i.e., organizational complexity and fleet size. Larger organizations may be more likely to conduct maintenance in-house than smaller organizations. Among the many effects of leasing vs. buying, non-warranty maintenance costs are shifted from the fleet to the leasing company. The overall effect of a shift to leasing is discussed as a separate determinant, below.

Upfront Costs of acquiring trucks cause decisions to be made about whether to acquire new or used trucks and whether to purchase or lease. As introduced in the section on truck availability, COVID-19 related supply chain disruptions have sharply increased both the price of used trucks and waiting times for new trucks (introducing a new type of upfront cost associated with such delays). Distinct from the delayed truck turnover are effects on financing truck purchases.

- Newly-formed fleets report being unable to finance purchases of new trucks and an inability to lease new trucks. This leads them to buy used trucks, making them one of the markets for trucks sold by other fleets, i.e., fleets who have decided a truck has reached a point of increasing maintenance costs, declining fuel efficiency, and increasing likelihood of requiring expensive repairs.

Total Cost of Ownership has multiple meanings across fleets who use it: some costs may be counted by some fleets but not by other fleets, the same categories of costs may be accounted for differently, analysis may be conducted "on-average" across the fleet (or similar trucks in the fleet) or individually for each truck in the fleet. Some fleets perform detailed cost analyses that conform to what might be called the "standard model" of a TCO. These TCO analyses may be used to decide both which trucks to retire—based on the historical data of the fleet's trucks—and which trucks to buy—based on expectations of future costs. The use of TCO is one example of a determinant we hear across the widest possible range of fleets—literally from the smallest possible (an owner-operator running one truck) to the largest fleets we interviewed.

Across a wide range of fleet size, we heard from fleets who don't use TCO. They may be using more analyses more sophisticated than TCO or as discussed under the Maintenance determinant, a simple heuristic. A few fleets talk about advanced metrics that—though the term "TCO" is not mentioned—must contain a similar analysis. For example, Fleet 55 is operated by a food producer. Food production and the fleet are managed in part using a "cost to deliver" metric that is as specific as a single Stock Keeping Unit (SKU, i.e., the bar codes attached to every product).

The elements of this metric include the total cost of owning and operating specific types of trucks and the costs to manufacturer specific products.

We've already described heuristics that usually stand-in for maintenance costs and requirements, e.g., total miles. Another heuristic that stands in for total cost is vehicle age, either actual age in years or model years. The use of these may be more common for trucks in lower mileage applications such as heavy-duty drayage. The use of these heuristics is often a function of external requirements, i.e., emissions requirements that "age out" trucks. This was also referred to in interviews as trucks "*CARBing out*."

Driver satisfaction is another determinant elevated in importance by COVID-19. Several fleets report there was a driver shortage and attendant problem of driver retention prior to the COVID-19 pandemic; many convey the pandemic made this problem worse. At the extreme, one interviewee stated their annual driver turnover rate is 100%. While there are several ways fleets might retain drivers, those pertaining to truck turnover sound subjective. Indeed, one interviewee indicated that though they attempt to account for driver satisfaction in their decisions about what trucks to buy, their cost model is "consistent," but their treatment of driver satisfaction is "more subjective." Driver satisfaction may be linked to other determinants (see the previous example regarding fuel efficiency).

Driver satisfaction has two effects on truck turnover.

- First, fleets report turning over trucks more quickly to be able to offer their drivers newer trucks. This is believed to be an inducement for drivers to stay with the fleet. In some cases, though, truck specifications are made despite the expressed opinions of drivers. One fleet noted a third-party required their trucks to have "all the safety features." This included cameras in the truck's interior which the drivers disliked.
- Second, driver satisfaction is expressed as a conservative force, something resisting change in truck design and performance: drivers want new trucks, but they want them to be the same truck they had before.

Taken together, the effect of driver satisfaction on turnover seems to be a cause for turning over trucks more quickly while propagating trucks that are not too dissimilar from drivers' experience of truck driving throughout the on-road fleet.

Leasing accounts for a smaller share of truck acquisitions, but fleets and leasing companies report that share is presently increasing.

- Leasing shifts control of fleet truck turnover away from the fleet and to the leasing company.
  - Lease periods start to define when trucks are replaced rather than whatever determinants or processes fleets used prior to leasing (and may continue to use for any trucks they continue to purchase).
  - Even if the lease period can be negotiated, this time-based heuristic becomes a new determinant in fleet turnover.
  - Reports of this effect tend to emphasize that truck turnover is quicker for leased than for owned trucks.
- Leasing shifts costs from fleets to leasing companies. These include the costs of running truck maintenance programs and reporting costs to regulatory agencies including costs

associated with emissions testing and certification. These cost shifts may not result in a actual reduction in a fleet's cost of acquiring, operating, and retiring trucks (if lease payments are higher than purchase payments) but can reduce back-office costs of running the fleet organization.

Renting is not widely used to acquire many MDHD vehicles. Fleets may rent trucks if they see large, but seasonal or otherwise temporary increases in demand for their services or wish to test a new market and require additional or different trucks for a (possible) short-term. In effect, renting is a way to turnover vehicles on a cycle counted in weeks and months rather than years.

Social networks

Brand and dealer loyalty are a commonly reported example of the effects of networks and relationships on truck acquisition and retirement decisions. Loyalty can proscribe the types of trucks and truck specifications a fleet considers when it does acquire a truck—in effect, loyalty replaces any notions of "calculated" decision making.

- Trucks may be replaced as a matter of routine by a newer version, often from the same dealer. In the extreme, this amounts to at least an informally known—if not formally written or codified—company policy.

External Effects

External effects tend to be imposed on all fleets, but the responses of fleets are not the same. Air quality and emissions regulations are foremost among the external effects discussed by fleets operating medium- and heavy-duty trucks in California. Decisions by manufacturers about discontinuing products or adding new products also affect a wide variety of fleets, who react in a variety of ways. Three regulatory determinants are mentioned repeatedly across the interviews.

Diesel emission fluid (DEF) systems started making their appearance in 2010 as part of truck manufacturers response to new truck emissions limits. Regardless of the effectiveness of DEF systems at reducing emissions, no one interviewed—including truck manufacturers—have anything good to say about these systems. In advance of the appearance of DEF systems, fleets took one of two actions to (temporarily) avoid buying DEF-equipped trucks:

- Accelerate truck turnover, i.e., buy more pre-DEF equipped trucks, so that fewer or no trucks would have to be acquired during the first few years; or,
- Delay truck turnover, i.e., once DEF-equipped engines started appearing in new trucks, delay retirement of pre-DEF trucks.

The effect on the total on-road fleet sums to the same thing: a large, one-time cohort of pre-DEF trucks on-road compared to what "normal" turnover would have produced.

Prohibitions on registering older vehicles recently implemented by CARB disallow the continued registration for on-road use of older diesel-powered MDHD vehicles. The age limits affect fleet truck choices, in most cases assuring a fleet purchases a truck of an age that it is still compliant and will remain so for the intended duration of ownership of that truck by the fleet. In this sense these requirements do not appear to affect turnover rate but do act to limit which trucks can be considered for acquisition. This determinant is mentioned by smaller fleets, fleets that buy used trucks, and fleets that have heavy-duty trucks in short mileage applications such as drayage in which the truck may "age-out" before it wears out.

Rules specific to drayage trucks are discussed by drayage fleets. To the limited extent generalizations are possible based on the small, stratified sample used in this study, drayage operators appear unlikely to be among the largest fleets; though we have interviewed large companies operating out of multiple ports around the nation, many drayage companies are small, local businesses operating out of a single port (or port "complex" such as San Pedro, California). Further, these smaller drayage operators may be more likely to buy used heavy-duty trucks. As such, drayage is a use case in which older, class 8 trucks may "age-out" per CARB regulations before they wear out in the sense the fleets would be looking to retire them based on increasing maintenance costs and/or decreasing reliability.

Incentives intended to aid fleets to experiment with new technologies such as electric trucks present both positive and negative—or at least "non-positive"—determinants of fleets' decisions about experimentation with advanced technology. As will be discussed in the section below on fleets consideration of alternative fuel trucks, incentives to participate in advanced truck technology demonstration projects or to acquire advanced technology trucks are positively affected by the availability of incentives from outside the fleet. In this sense,

- Incentives may be seen to, at least on a small scale to-date, accelerate uptake of new advanced technology trucks. However, this effect is selective because,
    - The capabilities of the trucks or their requirements for supporting investments, e.g., charging or fueling infrastructure, may limit them to specific use cases, and/or
    - To large, bureaucratically complex organizations,
        - The use case for the advanced technology truck may be a niche within a larger set of such organizations' truck use cases, and
        - The organizations have the personnel and expertise to be aware of the incentives and manage the application and ongoing administration of any resulting programs.
    - In contrast, smaller, simpler fleets are likely to fail both these conditions, i.e., if they have only one use case, they may believe the advanced technology truck does not match it, and the fleet may be less likely to be aware of the incentive and less likely to have the personnel to manage application and ongoing administration.

Assembly Bill 5 (AB 5) went into effect in the trucking industry on June 30, 2022, after a federal injunction exempting trucking companies was lifted. AB5 was intended to prevent businesses from classifying some workers as independent contractors rather than employees. Independent contractors do not have to be provided benefits such as health insurance, minimum wage, overtime protections, paid sick days, workers' compensation, unemployment insurance and other protections to which employees are entitled.

- The potential effects on the turnover of the on-road fleet of trucks in California may be complex and are presently unclear. If owner-operators of trucks are reclassified as employees, and if this causes them to either leave the trucking industry or to relocate out-of-state, these will exacerbate the driver shortage and reduce the number of available trucks.

- Under AB5, many independent California truckers who previously were independent contractors would be classified as employees. From the perspective of owner-operators, this is not necessarily desirable if they do want to retain maximum control over when they work, how much they work, what loads they haul, and a host of other decisions—control they feel may be eroded if they are reclassified as employees of the companies whose freight they are moving.
- In the near term, AB5 may exacerbate the truck driver shortage in California if drivers pursue opportunities in other states. AB5 affects most independent and owner-operator drivers. One large trucking logistics company estimates there are 70,000 owner-operators driving in California who will be affected by AB5.

The **Financial Accounting Standards Board (FASB)** recently changed rules affecting how leases appear in company accounts. The effect of the changes on the relative financial advantages of buying vs. leasing trucks is yet unclear but were mentioned by several interviewees. These rules came into full effect for private fleets in the year 2020. The first annual reporting under the new standard is not due until the end of 2022. The changes have generally made leasing financially more favorable than they had been under the older accounting standards. Most fleet vehicle leases are operating leases. Unlike capital leases, operating leases did not need to be reported on a company's balance sheet prior to these recent changes. Therefore, operating lease payments were treated like rental expenses. This effectively reduced the company's profit and thus tax liability. Under the new rules, the value of leased vehicles must be listed as an asset. It is difficult to determine the impact of these accounting rule changes on fleet vehicle acquisitions. The tax implications are not well understood and as the rules affect all leases, including property, may be outside the domain of a fleet decisionmaker.

Truck Availability

Availability of desired trucks*,* or unavailability, causes fleets to either or both delay retiring trucks and modify their truck acquisition practices. While COVID-19 related supply chain delays were the most oft cited examples of lack of truck availability, these could be exacerbated by fleet's existing practices. Supply-chain disruptions were cited as the source of delays in the delivery of trucks, extending wait times from weeks to months (and beyond one year in the extreme). Faced with such delay's fleets took these actions:

- Hold trucks that would otherwise meet typical retirement criteria, e.g., put more miles on trucks than typical.
    - In the extreme, fleets were still forgoing either replacing trucks or expanding their fleet with an additional truck as of the time of their interview.
- Acquire a "non-spec" truck, that is, acquire whatever suitable truck a dealer might have on a lot rather than a truck that meets exact specifications.
    - This can be more likely to happen in fleets operating limited (even single) truck specifications.
- Larger fleets who may order multiple trucks at a time may be favored in these delay queues over small fleets buying a single truck.

Non-COVID-19 supply changes include truck manufacturers ceasing to produce a desired or required truck. These cases may cause a fleet to change manufacturers—from which other changes may flow as in the example in the opening paragraphs of this section.

Task 3: Decision-making Typology

A typology of decision-making pertaining to decisions to acquire and retire trucks among fleets operating medium- and heavy-duty trucks in California is created based on three dimensions: Structure, Adaptation, and Complexity.

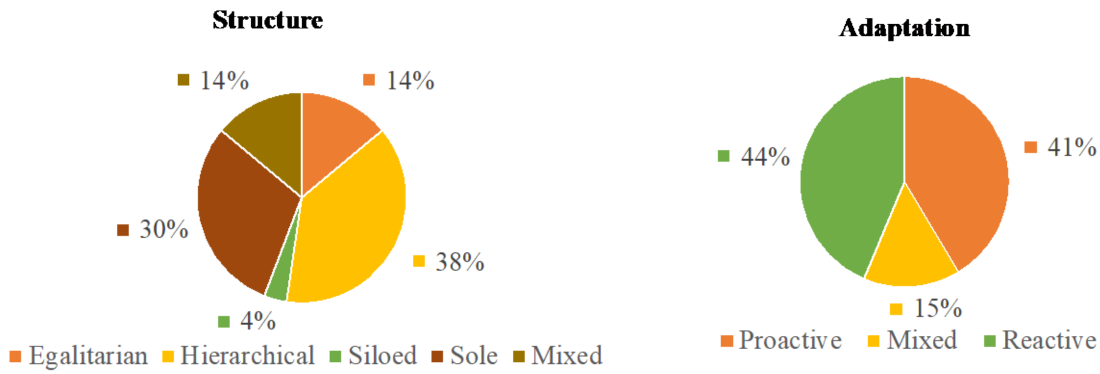
Structure describes the organization of decision-making pertaining to truck acquisition and retirement within a single fleet. The distribution of such structures across participating fleets is shown in Figure 10. The basic distinction is whether a single person makes these decisions by themselves (sole) or with other people in the organization (group). "Group" decision making is further divided based on the relationships between the group members. Egalitarian groups share a similar level of responsibility; they may play distinct or overlapping roles but have a process in which decisions are made collectively. Hierarchical groups consist of people who have different roles and different levels of responsibility or authority over truck acquisition and retirement decisions. Decisions to acquire or retire trucks must be approved by people with increasing levels of responsibility or authority all the way up to the person with the highest authority.

We observed a very small number of fleets in which different parts of truck acquisition or retirement decisions were made by people with independent authority over their aspect of those decisions. Such "siloed" groups have only people with different responsibilities, operating largely independently of each other. One person—in practice, it may be the person with budget authority—may get the final opportunity to approve or disapprove, but each decision about whether any transaction is necessary or desirable, what trucks to acquire, how to acquire them, i.e., buy or lease, and so on are the province of different people in the group. As so few of these are observed, they are included in the typology table, but no case study is prepared.

Further, there are hybrid structures combining egalitarian, hierarchical, siloed, and sole decision making though we observed few such fleets. For example, authority for different elements of a truck acquisition may be siloed within different groups within which egalitarian decision structures are observed. Nothing about the definitions of decision-making structure used in this report precludes the possibility that fleets with a sole decision maker engage consultants or other firms outside their fleet to participate in truck acquisition and retirement decisions. Such arrangements are captured in the "linking" determinants.

Adaptation describes whether the fleet's truck acquisition or retirement decisions tend to lead (proactive) or follow (reactive) internal policies and external factors. The most common example in the data are fleet responses to emissions regulations. A proactive fleet enacts acquisition or retirement decisions based on planning done in advance of known dates of new regulations. A reactive fleet lets the new regulations come into effect before addressing any effects on their truck acquisitions or retirements. A reactive fleet may not know there are new external conditions; we've reports from fleets who only learned they would no longer be able to operate an older truck when they attempted to renew its registration. A few fleets described mixed adaptation strategies; some aspects of truck turnover decisions are described as proactive while others are described as reactive. However as noted in the introductory paragraph, no case study is prepared of "hybrid adaptation" fleets. The distribution of fleet adaptation is shown in Figure 10.

Figure 10 Decision Making Structure and Adaptation, percent

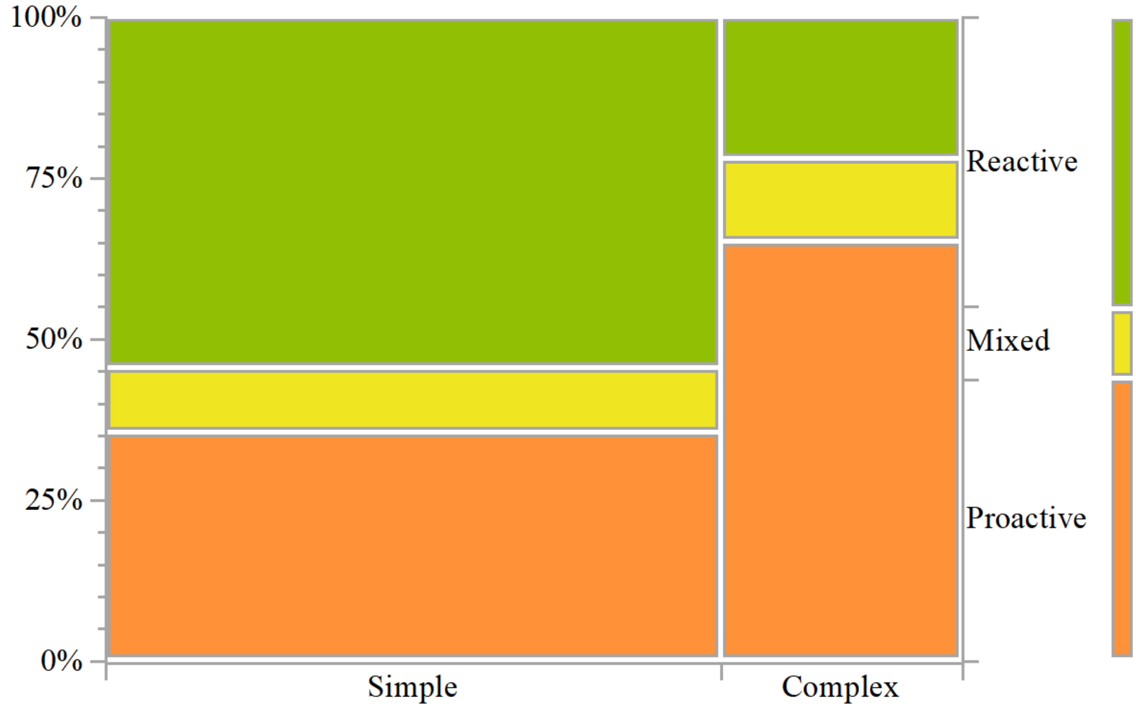


Complexity is a summary judgement by the researchers about the decision making in a fleet. To make the measure practical for the purposes of creating a typology, complexity is reduced to a binary distinction between simple and complex. Complexity is taken to be a function of how many determinants go into truck acquisition and retirement decisions, the importance of each determinant to decisions, the details of data collection for the determinants, and the complexity of any algorithm used to synthesize determinants. As extreme examples, basing truck retirement decisions on total cost of ownership calculations using real-time data from telematics in every truck is complex while basing the same decision on a total mile heuristic using periodic checks of the trucks' odometers is simple. Nearly three-fourths of fleets (72 percent) are scored as simple decision makers while the remaining 28 percent are scored as complex. Unlike structure and adaptation, there is no accounting of mixed simple and complex decision making; if any part of the decision making is complex, the fleet is scored as a complex decision maker.

In our sample, Adaptation and Complexity are correlated: simple decision making is more likely to be reactive while complex decision making is more likely to be proactive (Figure 11). There is some evidence of association between Structure and Adaptation, though the sample size is too small and the degrees of freedom are too high to statistically assess confidence in these associations: hierarchical and sole decision making may be more likely to be associated with reactive decision making while egalitarian decision making may be associated with proactive decision making. As for an association in the sample between Structure and Complexity, it is clear sole decision makers tend toward simple decision making (of sole decision makers, 80 percent are characterized as simple), but there is no evidence of a broader association between Structure and Complexity.

Fleets are sorted into the typology as shown in Table 2. Table 2 is simplified by excluding fleets of mixed Structure and Adaptation. Further, as Adaptation and Complexity are reduced to simple binary opposites, fleets may not represent a "pure" case of a type, that is they may exhibit both reactive and proactive as well as simple and complex decision-making. Such a fleet is placed in the typology based on whether on balance a fleet is judged by the researchers to be more like one type than another within these two dimensions. Further, as discussed in the definitions of the dimensions and types, we acknowledge that hybrid types exist. In the interest of clarity, the case studies in this section do not use these hybrid-types to illustrate the types.

Figure 11 Decision Making Adaptation by Complexity, percent



n = 82; chi-square = 7.306; p = 0.026

Table 2 Typology of Fleet Decision Making Regarding Truck Acquisition and Retirement, Fleet Identifier Numbers

Structure:	Group-Egalitarian		Group-Hierarchical		Group-Siloed		Sole	
Adaptation	Simple	Complex	Simple	Complex	Simple	Complex	Simple	Complex
Proactive	40, 80, 82, 93	**13, 15**	**42**, 47, 53, 55, **56**, 59, 76, 79, 89, 90	**5**, **39**, 44, 67, 87	—	**1, 12**	26, **27**, **31**, 70, 74, 95	**16**, **33**, 60
Reactive	**49**, 50, **61**, 77	—	23, 38, 41, 51, 52, **63**, 72, **73**, 86, 88, 92, 94	**37**, **58**, 78, 85	71	—	**19**, **30**, 32, 43, 46 57, 64, 68, 75, 81, 91, 96, 98	48

Note: Fleets in **bold** are those used in the case studies in the Discussion. Not all numerals from 1 to 99 appear as interviews are numbered consecutively but not all interviews are of fleets and fleets of mixed structure and adaptation are excluded from the table.

The full complexity of the typology, including a summary grouping of all possible combinations of mixed decision-making structures and mixed adaptation is shown as a pie chart in Figure 12. Structure is coded by color (blue = Egalitarian, yellow = Hierarchical, and so on). Adaptation is coded by shade (lightest = Reactive to darkest = Proactive). Complexity is coded by pattern (solid = Simple and patterned = Complex). While it may be difficult to discern the precise meaning of a given slice of the figure, the overall impression reinforces the primary finding of this report, i.e., there is wide variation across fleet types and no behavior explains what most fleets do. Even the most common type—simple reactive decision-making within a hierarchical structure—was observed in fewer than one-in-five fleets.

In general, the typology does not replicate basic descriptive measures such as fleet size, whether fleets acquire new or used trucks, fleet ownership and operational models, and use applications, i.e., the dimensions of the decision-making typology (Table 2) are not merely proxies for the dimensions of the sampling framework (Table 1). Fleet size is associated with the typology dimensions of Complexity and Structure. Regarding Complexity, the percentage of fleets who make decisions via complex processes increases with fleet size (Figure 13).

There is also a relation between fleet size and decision-making structure (Figure 14). Truck turnover decisions are most likely to be made by a sole decision maker in small fleets (≤ 20 trucks, 52 percent). In large fleets, those decisions were most likely to be made within hierarchical structures (> 150 trucks, 59 percent). Medium-size fleets are about equally likely to make these decisions via sole decision makers (32 percent) or hierarchies (36 percent).

Finally, there is an association between Complexity and whether fleets acquire only new trucks, only used, or a mixture of both (Figure 15). While there are fleets of all sizes that use simple decision processes, those fleets who acquired only new trucks were least likely to use simple processes (43 percent) while no fleet that acquires only used trucks is observed to do so via complex processes. Rather, all fleets in the sample that acquire only used trucks make simple decisions affecting truck turnover.

Figure 12 Fleet Typology Allowing for Mixed Structures and Adaptations, percent

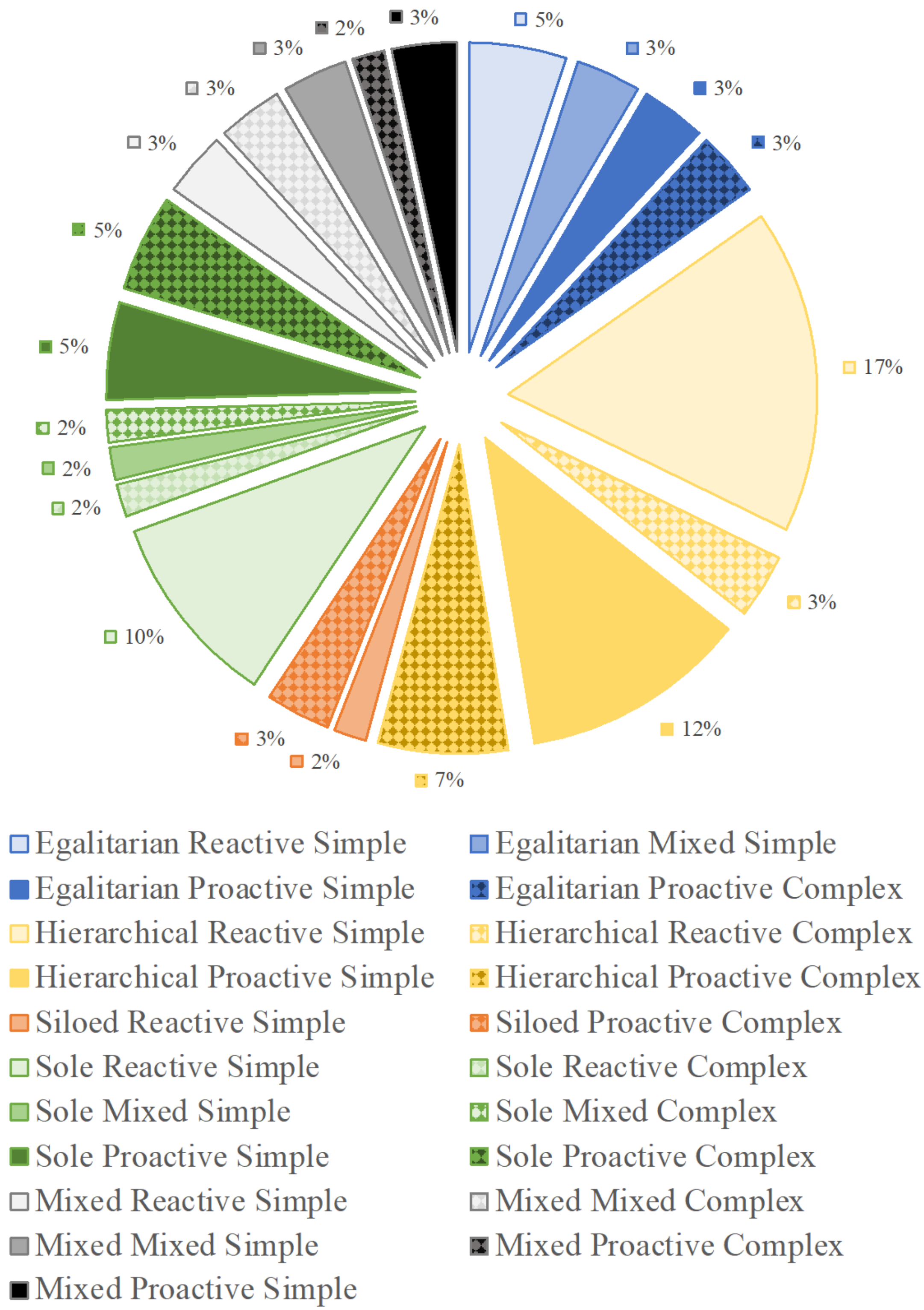


Figure 13 Decision-Making Complexity by Fleet Size, percent

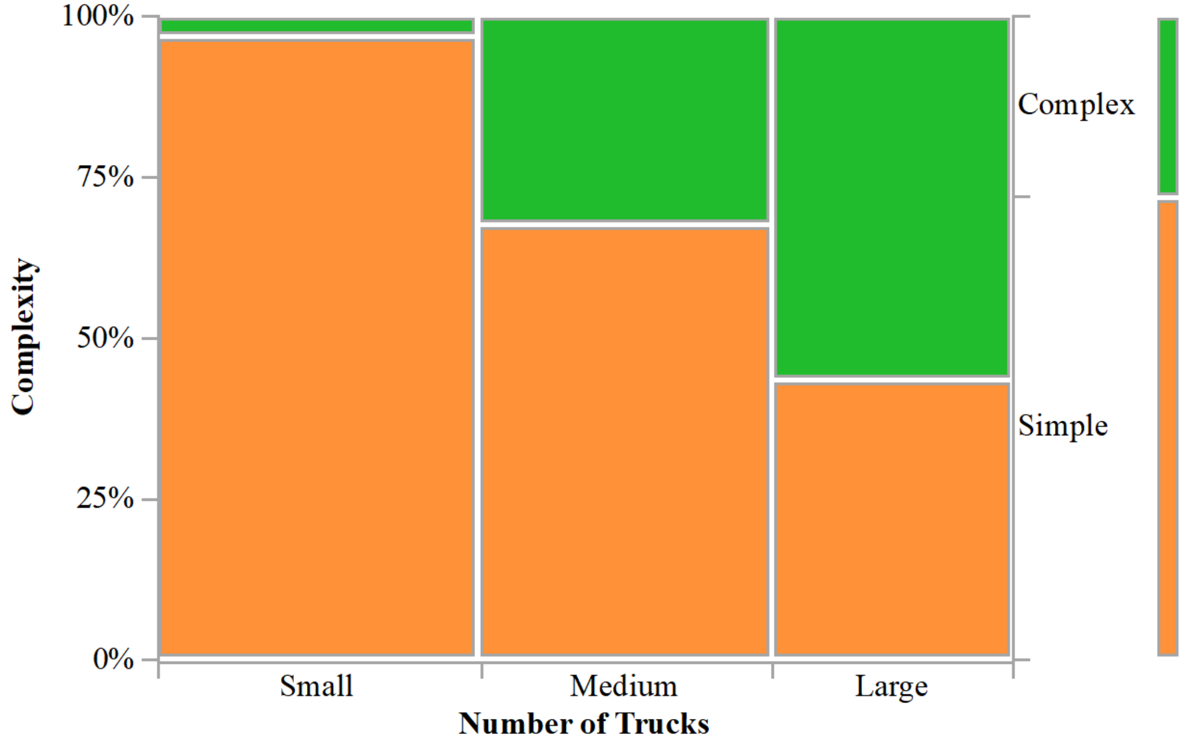


Figure 14 Decision-Making Structure by Fleet Size, percent

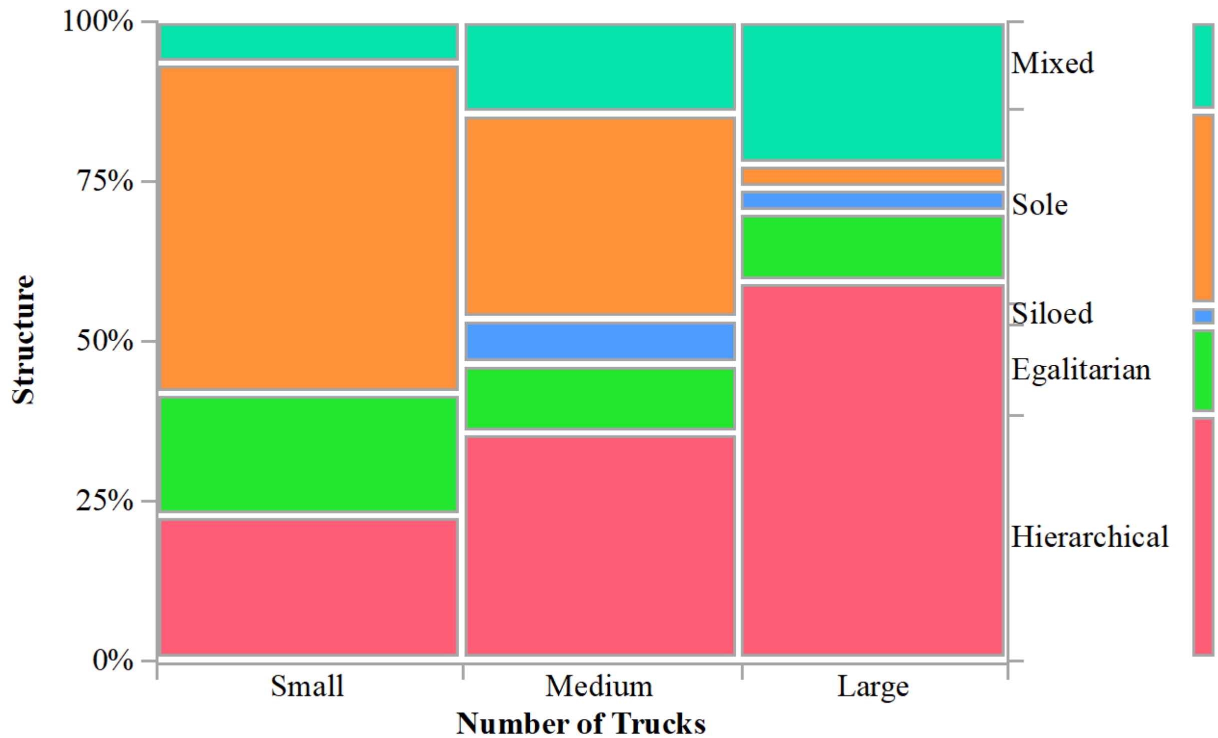
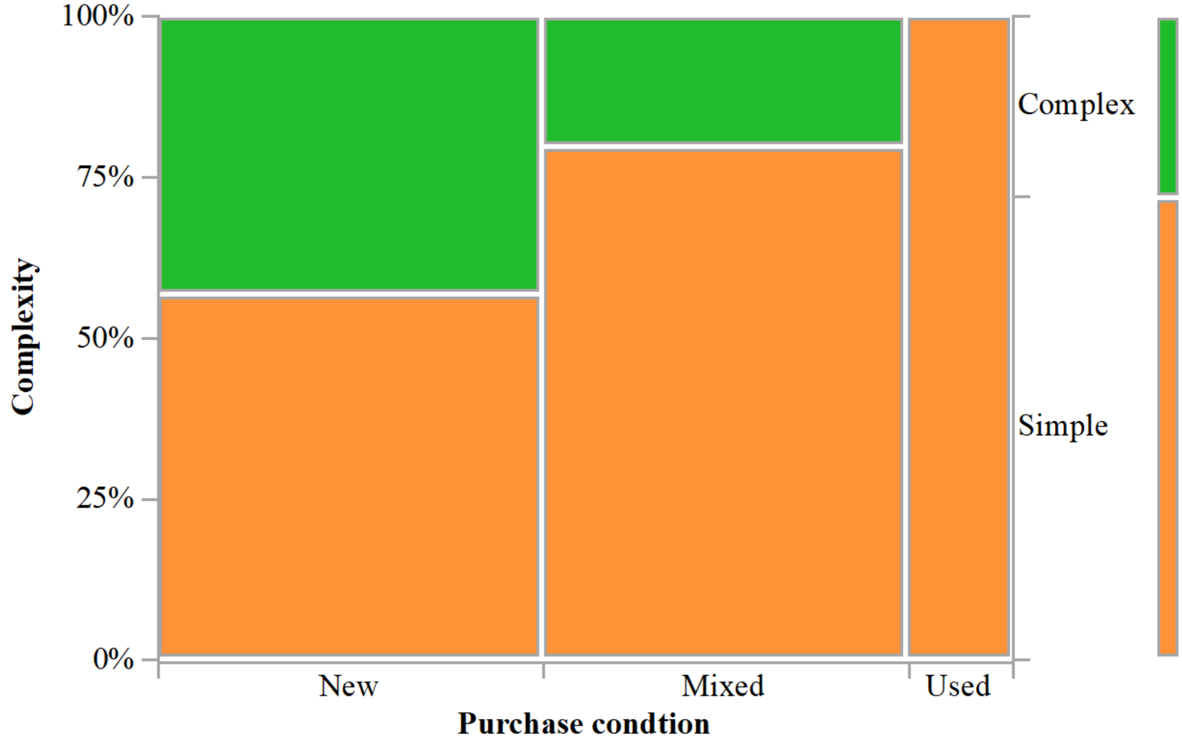


Figure 15 Decision-Making Complexity by Truck Acquisition, percent



DISCUSSION

The discussion is presented in three sections. First are case studies of the decision-making types. Second is an extension to and expansion on the determinants of truck acquisition and retirement as they pertain specifically to the case of fleets' consideration of alternative fuel trucks, i.e., battery electric, fuel cell electric, and natural gas (compressed or liquefied). Third, discussion is given to observations from the interviews of determinants affecting the freight sector broadly, that is, discussing determinants from an industry-wide perspective rather than from the point of view of individual fleets as in the case studies.

Case Studies of Decision-Making Types

Case studies are made of "types" based on the dimensions defined in the previous section. While the typology defines 24 types, based on data availability and the use of comparison-contrast of two fleets to illustrate a type, these10 case studies are presented:

1. Simple, reactive decision making in an egalitarian structure.
2. Complex proactive, decision making in an egalitarian structure.
3. Simple, proactive decision making in a hierarchical structure.
4. Simple, reactive decision making in a hierarchical structure.
5. Complex, proactive decision making in a hierarchical structure.
6. Complex, reactive decision making in a hierarchical structure.
7. Complex, proactive, siloed structure.
8. Simple, proactive decision making by a sole decision maker.
9. Simple, reactive decision making by a sole decision maker.
10. Complex, proactive decision making by a sole decision maker.

Case studies illustrate how fleets of each type make decisions about acquiring and retiring trucks. Each case study starts by providing a brief description of the two fleets. This is done with data presented with these measures presented in tabular form:

1. How large is the fleet as measured by the number of trucks?
2. Over what geography does the fleet operate?
3. Do fleets acquire trucks via purchase, lease, rental, or some mix of these?
4. Do fleets acquire new, used, or both new and use trucks?
5. What broad weight class of trucks does the fleet acquire and what are their uses?
6. What is the ownership and operating models of the fleet?

The case "type" is reiterated in full, that is the structure, complexity, and adaptation are described and illustrated with quotes from each fleet. This illustrates how the fleets are similar in their decision making regardless of how closely their basic descriptions match. Within the discussion of complexity, the determinants of truck turnover decisions and how they are used are described for the two fleets. Each case concludes with a summary statement tying back to the decision-making type.

Case Study 1: Simple, reactive decision making in an egalitarian structure.

Fleets 49 and 61 are categorized as having simple, reactive decision-making within an egalitarian organizational structure. Their basic operational descriptions are in Table 3.

Table 3 Case Study 1: Fleet 49 and 61 Descriptions

	Fleet 49	Fleet 61
Number of medium- and heavy-duty trucks	3	30
Largest region of operation	International	National
Acquisition types	Purchase	Purchase
Acquisition condition	Mixed	New
Medium- and Heavy-duty use cases	Medium-duty delivery; Heavy-duty long-haul	Heavy-duty long-haul
Ownership model	Centrally-owned	Centrally-owned
Operating model	For-hire	For-hire

Fleet 49 is owned by three individuals, each with equal influence over truck acquisition and retirement decisions. In fleet 61, the interviewee is the company's Operations Manager; his father is the President. They work together to make collaborative decisions on truck acquisition and retirement decisions. Because of the presence of multiple individuals with equal influence over decisions, fleets 49 and 61 are categorized as having an egalitarian decision-making structure.

Both fleets 49 and 61 factor maintenance costs and manufacturer loyalty into their acquisition decisions. When purchasing used trucks, fleet 49 places a strong emphasis on finding trucks they believe have been well maintained by the previous owner so fleet 49 can keep their maintenance costs down. This leads them to purchase trucks from Penske (fleet 49 believes Penske will fix any issues the truck has before selling it) and from other owner-operators (who fleet 49 believes take better care of their trucks than do large fleets). Fleet 49 uses a multi-level truck mileage heuristic to limit the used trucks they consider acquiring. For heavy-duty trucks, they look to purchase trucks with either less than 50,000 miles or more than 400,000 to 600,000 miles. Fleet 49 believes that if a truck is going to have exceptional maintenance or reliability issues, these will arise before 50,000 miles (thus if a truck gets to 50,000 miles without a problem, it will likely continue running well). Fleet 49 believes that trucks that are beyond the higher mileage heuristic are likely to have already had any major overhauls they will require.

In contrast, Fleet 61 uses their own maintenance costs as a primary determinant of truck retirement and as their rationale for avoiding buying used trucks (rather than new trucks). Fleet 61 evaluates each of their truck's maintenance costs once a year. They have concluded that trucks generally last four to five years before the diesel exhaust fluid (DEF) systems began causing issues and the trucks "just start going crazy," at which point trucks are considered for retirement.

Both fleets consider manufacturer loyalty a primary acquisition consideration. Fleet 49 purchases Freightliner trucks because they believe these trucks have lower upfront costs and better overall performance. Meanwhile fleet 61 purchases trucks exclusively from Volvo because of the President's previous positive experiences with the brand and the simplicity of operating only one truck type. The fleet 61 interviewee states, "our drivers, our mechanics, and everybody, they know Volvo and they like Volvo." This familiarity, combined with what Fleet 61 believes is a lower purchase price and quieter driving experience leads them to remain loyal to Volvo.

Beyond their shared turnover determinants of maintenance costs (even if it is implemented differently in the two fleets and produces different results) and brand loyalty, each of these two fleets has determinants it does not share with the other. Fleet 49 emphasizes upfront costs and resale value as inputs to their purchase decisions in a way Fleet 61 does not. Fleet 49 is a newer company than fleet 61, having been in operation less than two years. Because of this, they are unable to lease trucks as leasing companies require at least two years of tax returns for a fleet before they will lease to it. Fleet 49 is also cash constrained, leading them to purchase used trucks and rent trucks to meet fluctuating demand. They hope to switch to leasing trucks in their next acquisition cycle. While the company is not old enough to fully understand their fleet's operating costs, they try to combine the purchase and maintenance costs into a "rudimentary" TCO-like calculation that drives their acquisition decisions.

Fleet 61's decisions were more focused on emissions regulations, supply chain concerns, and the impact of AB5 when making their purchase considerations. The interviewee states the high costs and large number of regulations in California (including emissions regulations and AB5) has made him, "definitely consider" not working here. He feels leaving would be easy to accomplish because their headquarters are already out of state. They are currently purchasing trucks that keep up with California emissions regulations, but do not know how much longer they will do this. The interviewee discussed being constrained in the number of trucks they can purchase presently due to COVID-induced supply chain shortages stating, "there's no trucks in the market right now." This caused them to continue operating their current trucks for longer than they normally would.

When retiring trucks, fleet 49 states they plan to use trucks until the company mechanics say the trucks are no longer reliably operable, at which point they will be scrapped. Fleet 61 relied primarily on a 700,000-mile heuristic to trigger retirement. On occasion, Fleet 61 will retire trucks before they reach this limit if they are, "really giving [us] problems [and] breaking down all the time," in which case the company will, "fix what we can, and we'll sell it as is."

The relatively small number of determinants used in the purchase decision of these fleets as well as their relatively simplistic use leads to the categorization of these fleets as having a simple decision-making process. While both fleets track their costs to some degree, neither uses a detailed overall cost calculation nor has policies in place to guide their decisions.

Both fleets are classified as reactive, i.e., they react to conditions external to their organization rather than proactively plan for them. The interviewee for fleet 61 is pushed to alter their purchase decisions when changes in regulations go into effect. They do not stay up to date on information regarding regulations but rather wait for CARB to notify them of changes they need to make. Fleet 49 was similarly unaware of the California requirements, stating that they did not know whether their pre-DEF 2003 truck met regulations. That truck does not operate in California so it had not been a concern yet, but they would investigate it if they needed to.

These two fleets illustrate that despite their shared decision-making type they are different in ways that change how their fleets turnover. This reinforces the overall message of this report about the tremendous variability across fleets. Even at the level of a decision-making type—the highest level of abstraction used in this study—two “similar” fleets differ in ways that affect what determines their truck acquisition and retirement decisions. Further, fleet 49’s determinants may be expected to change in their next acquisition cycle as the business builds the credit rating that would allow it to finance the expense of new trucks.

Case Study 2: Complex, proactive decision making in an egalitarian structure.
This case study draws on Fleets 13 and 15; their basic operational descriptions are in Table 4.

Table 4 Case Study 2: Fleet 13 and 15 Descriptions

	Fleet 13	**Fleet 15**
Number of medium- and heavy-duty trucks	1,500	700
Largest region of operation	International	National
Acquisition types	Mixed	Mixed
Acquisition condition	New	New
Medium- and Heavy-duty use cases	Heavy-duty long-haul	Heavy-duty long-haul and short-haul; Medium-duty delivery and vocational
Ownership model	Centrally owned	Centrally owned
Operating model	For-hire	Dedicated

The companies in which Fleets 13 and 15 reside are categorized as having an egalitarian decision-making structure. Both have multiple people with similar levels of influence providing input into the decision-making process. Decisions in Fleet 13 are made by a team including the interviewee, representatives from the leasing companies, manufacturer or dealership representatives, a fleet management company, company drivers, and division leadership. While the interviewee has a lot of authority to make decisions about fleet changes, he actively seeks and incorporates feedback from other stakeholders into the decisions. Divisions within the company have autonomy in their truck selection. For example, the interviewee notes that most of their fleet operates leased Freightliner trucks because this is what he prefers. Despite this, their Iowa division purchases trucks, their Minnesota division runs Volvo trucks, and their North Carolina and Tampa divisions run International trucks. The interviewee states that this variation comes from the group decision-making process,

> *“I really count on the division themselves and…what kind of feedback their drivers are bringing back.”*

Similarly, the interviewee from Fleet 15 makes decisions as part of a team of 14 people who work on fleet operations, asset management, engineering, and in-house maintenance, all with similar influence over the acquisition decision.

Both Fleet 13 and 15 consider internal policies and goals, direct cost accounting (a TCO), fuel economy, maintenance costs, safety, driver retention, and the availability of new makes and models in their acquisition decision. The company in which Fleet 15 resides has a sustainability plan that guides vehicle acquisitions and has led them to discontinue relationships with vendors who,

> *"…don't have any type of forward thinking…they could make something real cheap, but there's no plan in place…so we elected to not do business with a company like that."*

The interviewee from Fleet 13 stated the company "*has a lot of green initiatives*" and are working to lower their carbon footprint using renewable diesel, which is used in about 60% of their trucks.

Driver retention plays a large role in the decision-making process for both fleets. Fleet 15's strategy for retaining drivers includes only purchasing new trucks with automatic transmissions, as well as giving drivers regular shifts each week. Fleet 13's strategy includes seeking regular feedback from drivers, leading Fleet 13 to only acquire trucks with automatic transmissions, high levels of reliability, strong safety features, and good maneuverability. The interviewee also emphasized the importance of placing drivers in hotels at night rather than sleeper cabs.

Fleet 13 works with a third-party vendor to conduct a TCO analysis on new technologies before introducing them into the fleet. This TCO calculation includes projected maintenance, resale, and upfront costs. Decision-makers in Fleet 15 utilize a TCO analysis in determining truck replacement cycles. This includes estimates of maintenance, fuel efficiency, weight, safety, and upfront costs calculated for each use case. While not included in Fleet 13's TCO calculations, the safety and fuel economy related improvements in new truck models are used by decision-makers to determine the replacement cycle.

The high number of determinants used in the acquisition and retirement decisions, along with the use of TCO analysis and strong internal sustainability goals results in the categorization of these fleets as having a complex decision-making process.

Both fleets are categorized as proactive due to their strong internal sustainability goals, which have caused the companies to evaluate their emissions and begin researching or using alternative fuel vehicles. Fleet 13 runs renewable diesel in 60% of their trucks, CNG in 175 trucks, and is participating in demonstrations of electric trucks. While Fleet 15 does not currently operate any alternative fuel trucks, they are a manufacturer of hydrogen fuels and are in negotiations with multiple manufacturers to demonstrate fuel cell electric trucks (FCETs). The company hopes to transition to FCETs in the next 5 to 10 years. These goals demonstrate both companies' willingness to try new technologies beyond what they have been mandated to.

Fleets 13 and 15 illustrate a complex decision-making process resulting in proactive choices. Both fleets have an egalitarian structure which allows for the introduction of discussions on the possibility for new fuels and vehicle technologies.

Case Study 3: Simple, proactive decision-making in a hierarchical structure.

This case study draws on Fleets 42 and 56 to discuss simple, proactive decision-making within hierarchical structure. Their basic operational descriptions are in Table 5.

Fleet 42 is a construction company that operates nationwide. Their fleet is diverse with several trucks in every size category, including concrete mixers, highway tractors, dump trucks, flatbeds, box trucks, and Ford pickup trucks ranging from F250s to F650s. Trucks operate in a wide range of applications and many of the vocational trucks are customized upon acquisition to perform special tasks, as is common. Fleet 56 provides drayage service at the Port of Oakland and Port of Savannah (GA) and is looking to expand to Houston (TX). In California, they operate eight trucks (down from 16 pre-COVID) and in Savannah they operate 14.

Table 5 Case Study 3: Fleet 42 and 56 Description

	Fleet 42	**Fleet 56**
Number of medium- and heavy-duty trucks	117	24
Largest region of operation	National	National
Acquisition types	Mixed	Mixed
Acquisition condition	Mixed	Mixed
Medium- and Heavy-duty use cases	Short-haul, vocational (construction)	Drayage
Ownership model	Centrally owned	Centrally owned
Operating model	Dedicated	For-hire

Fleet 42's truck turnover decisions are somewhat dependent on field operations throughout the company. The equipment manager evaluates the fleet on an annual basis to identify high-mileage trucks to sell. The equipment manager then decides which and how many trucks to purchase and takes this information to the president for approval. After the president provides a *"little bit of input,"* the equipment manager begins searching for trucks to purchase. If there is a difference of opinion, the equipment manager will *"acquiesce and change to whatever [the boss] wants."*

The president is steadfast in his loyalty to Peterbilt and Ford trucks. The equipment manager will not even suggest other manufacturers, despite frustrations with the reliability of certain truck models. The equipment manager noted that these trucks were a significant cost burden on the fleet, yet *"the boss is willing to live with [it]."*

Accounting practices or tax implications also factor into Fleet 42's truck acquisitions. Though the interviewee did not specifically identify the cause, it is likely that the FASB rules for truck leases resulted in Fleet 42 leasing trucks for the first time about two years ago. Fleet 42 expects to significantly increase their lease holdings over the next few years.

Fleet 42 does not look at fuel economy or fuel costs determinants when purchasing. The interviewee reports fuel economy is a difficult metric to calculate and there is a general acceptance that fuel economy will be poor. The vehicles are often refueled on the job site by a tanker truck, so fuel consumption is hard to track. Furthermore, the trucks are often heavily loaded, so it is difficult to determine what is a good or bad fuel economy. Fuel costs are viewed as "just a part of the cost of doing business."

Fleet 42 uses simple mileage thresholds as the primary determinant for establishing truck turnover. Retirement mileage thresholds vary depending on the size and type of truck. For the smaller trucks, they *"pull them out of the fleet"* at about 300,000 miles. They used to use a threshold range of 250,00 to 300,000 miles before COVID-19, but they are keeping trucks longer because fewer new trucks are available. Another turnover determinant is CARB regulations.

Fleet 42 has been proactively moving trucks out of California into other states in anticipation of new regulations. Presently, they must move two more trucks to out-of-state jobsites by the end of the year (2022).

For Fleet 56, the distinction between leasing versus buying new trucks appears to be regional: trucks in California are leased while trucks in Georgia are purchased. Leasing allows Fleet 56 to acquire newer vehicles with better fuel economy, which is important because the California trucks average approximately 500 miles per day, compared to 30 miles per day for the Georgia fleet. Leasing also ensures they have newer trucks that meet port-specific standards.

Fleet 56 leases trucks for five years. The leased trucks have a mileage cap, so the company tracks mileage. They project future usage (miles) based on data from past years. They chose to lease from Penske after shopping around because they offer *"the best deal,"* and because Penske provides good service during the lease. Penske has dealerships across the country and are quick to respond if a truck breaks down. For the trucks the fleet owns in Georgia, the equipment manager presents a purchase request to the Chief Operating Officer (COO). Once the COO approves the request, it then goes to the Chief Financial Officer for approval (which is usually a formality).

Another of Fleet 56's acquisition determinant pertains to truck inspections. Every day, drivers must go through a weigh station and inspection facility enroute to the port. The interviewee offers that leased trucks have an easier and faster time getting through inspections because the inspectors recognize leased trucks are newer and generally well-serviced. Usually, the drivers do not even need to get out of the truck. Safety is a high priority for Fleet 56 but the emphasis is not so much on purchasing the safest trucks but rather keeping those already in operation safe through regular inspections and preventive maintenance.

Retiring non-leased trucks in Fleet 56 is based on maintenance costs. Fleet 56 keeps track of maintenance costs with the aid of daily driver inspections and through weekly and monthly evaluations. Trucks are sold when Fleet 56 sees a pattern of increasing repair costs. Trends rather than exact maintenance cost values trigger truck retirements. For example, diesel exhaust fluid (DEF) systems must be replaced frequently as trucks age. An increasing rate of invoices for DEF replacements is a signal for truck retirement.

Fleet 56's rigorous inspection program is a cost-saving measure. As explained, a broken headlight flagged by DOT inspectors could take a truck out of commission for three days while waiting for a part (supply chain issues have increased wait times). Fleet 56 may have to rent a truck during that time, resulting in a significant unplanned cost.

These two fleets are examples of simple, proactive decision making within a hierarchical decision structure. Both fleets required one or more people to approve truck acquisitions. Acquisitions and turnover determinants are uncomplicated. Leases and brand loyalty drive acquisition decisions while accumulated miles and maintenance cost trends trigger retirements. One fleet responded to CARB regulations by relocating trucks, the other relies on leasing to comply. Detailed recording keeping does not play a large role in fleet turnover. However, external determinants such as DOT truck inspections, CARB regulations, and federally mandated accounting changes have been dealt with in a proactive manner.

Case Study 4: Simple, reactive decision-making in a hierarchical structure.

This case study draws on Fleets 63 and 73 to illustrate simple, reactive decision-making in a hierarchical structure. Their basic descriptions are in Table 5

Table 6 Case Study 4: Fleet 63 and 73 Descriptions

	Fleet 63	Fleet 73
Number of medium- and heavy-duty trucks	250	3
Largest region of operation	National	CA Regional
Acquisition types	Purchase	Purchase, rent
Acquisition condition	Mixed	Used
Medium- and Heavy-duty use cases	Medium-duty and Heavy-Duty Short haul	Medium-duty Short-haul, Delivery
Ownership model	Centrally owned	Centrally owned
Operating model	Dedicated	For-hire

Fleets 63 and 73 exhibit simple, reactive decision making within a hierarchical decision-making framework. Fleet 63 operates approximately 100 medium-duty trucks and 150 heavy-duty trucks. Fleet 63 is an umbrella corporation for several companies. One of those companies owns all the fleet vehicles and leases them to the other companies. Each company has a fleet manager that oversees day-to-day operations, but all truck purchase and retirement decisions are made at the corporate level by the Corporate Transportation Manager (CTM) and the corporation owner. Fleet 73 is a small fleet; its owner was recently a single owner-operator who is trying to expand the company. The fleet provides local and regional delivery. It is presently contracted with a single large retailer to provide in-home and warehouse deliveries.

Purchase decisions result from discussions between the owner and TCM, but the final decision is the responsibility of the company owner. Truck acquisition and retirement decisions in Fleet 63 arise through a collaborative effort involving the two; both are integral to the decision and decision input is equally weighted. The TCM explains the process:

> *"I go to the owner of our company, we sit down, discuss what we need, and then he gets on the computer and starts trying to fulfill my needs."*

The decision process works, in part, because both individuals are self-described *"truck guys"* with significant driving experience.

Trucks are purchased through auctions, local dealers, and rental companies. After years of using different trucks from different manufacturers, Fleet 63 developed a loyalty to Freightliner trucks. Because of the type of work their companies perform—concrete construction—durable vehicles are highly valued. Freightliners seem to be able to handle the *"abuse,"* are relatively inexpensive to purchase, and have low maintenance costs. Likewise, fleet 63 tried many brands of medium-duty trucks before settling on Fords. Fleet 63 plans to continue using Freightliners and Fords, *"if it isn't broke, don't fix it."*

Fleet 63 uses a few simple determinants to aid in determining truck turnover rates. Age of truck and engine are the primary triggers for retirement. Mileage is also considered, to a lesser extent. Fleet 63 tracks engine hours and mileage using software designed to ensure trucks are kept in compliance for purposes of California and DOT roadway inspections. The same software alerts Fleet 63 when it is time to replace a truck. Decommissioned trucks are simply placed on their property with a "for sale" signed in the windshield. CARB regulations are also a turnover determinant. When trucks become inoperable in California because of CARB regulations, they re-assign them to other companies outside the state.

Fleet 63 cannibalized trucks for spare parts and sent trucks to the scrap yard until about six years ago. One day an individual drove by and saw two trucks destined for the scrap yard. The individual offered to buy the trucks for approximately three times more than what Fleet 63 was getting from scrapping them. After that encounter, resale became the standard practice.

Fleet 73 presently operates three trucks; it owns two and rents the third. The two owned vehicles are a 2015 and 2017 Freightliner Class 6 box truck; the rented truck (from Enterprise) is a Class 6 International box truck, model year 2020. One truck was purchased from Richie Brothers auction and the other from an Enterprise used truck lot. Fleet 73 delivers consumer products such as appliances for a big box store. One truck does warehouse delivery; two do home deliveries. Fleet 73 has only two employees. Truck purchases are initiated by the interviewee-employee who describes his position as the manager who *"takes care of all the logistics side of the company."* However, truck purchases must be approved by the other employee, his fiancée, who takes care of all financial matters. In this role she does not advise on the type of truck to purchase but rather simply decides whether they can afford to purchase a truck. Fleet 73 prefers Freightliner trucks because of their prevalence on the road and because the owner's cousin, who works for Freightliner, recommends the brand.

Fleet 73 does not appear to track costs carefully, if at all. The individual in charge of logistics (the interviewee) claims to *"crunch the numbers"* when considering whether to buy a truck. However, it appears he is looking primarily at the purchase price and loan payments. He also does *"research…[to] see how expensive it is,"* which again suggest the focus is almost entirely on the purchase price.

Fleet 73 rented a truck to cover overflow delivery demand that exceeded their two-truck capacity. Renting appealed to them because they could avoid being locked into a long-term financial commitment. However, they also believe that renting is an expensive alternative to buying. When speaking of rentals in general, the interviewee explained he felt like they were *"not really making any money by doing the rental."* On the other hand, the owner did seem to appreciate the fact that maintenance and repairs were subsumed in the price of the rental truck. The fact that they can immediately get a replacement for their rental if needed, is seen to be a benefit of renting.

Fleet 73 has only retired one truck— an 2007 International that could no longer be operated in California because of emission regulations. Fleet 73 was not aware of this until they tried to register the truck. Soon afterwards, the truck broke down and was sold for parts.

Fleet 73 would like to replace the rental truck with a purchased or leased truck. However, they are considering expanding the business to include freight movement (business to business). The rental truck would allow Fleet 73 to test this move without having to take one of their existing trucks out of its present service. But all options seem to be in play because they are also consider purchasing or leasing another truck.

These two fleets illustrate simple, reactive decision making within a hierarchical decision structure. Simple evaluations and heuristics are used to determine vehicle turnover. In both cases, the hierarchical structure involves only two individuals, but their roles are different. In Fleet 63 the owner is more involved in truck purchases about vehicle selection. In Fleet 73 veto power rests with an individual who is only concerned with the financial viability of a truck purchase. Few determinants play a role in vehicle turnover for either fleet and both seem to react to external factors, such as CARB regulations, rather than participate and plan for them.

Case Study 5: Complex, proactive decision making in a hierarchical structure.
This case study draws on Fleets 5 and 39 to illustrate complex, proactive decision making in a hierarchical structure. Their basic operational descriptions are in Table 7.

Fleets 5 and 39 are nominally similar in terms of their basic operational descriptions, differing primarily in that fleet 5 is dedicated to carrying the products produced by the entity that operates that fleet while fleet 39 is a for-hire fleet, i.e., it carries other entities' products. Both are large, complex organizations with the capability to organize and execute freight movements on a continental scale. Both fleets have explicit internal environmental, social, and governance (ESG) policies in place.

Table 7 Case Study 5: Fleet 5 and 39 Descriptions

	Fleet 5	**Fleet 39**
Number of medium- and heavy-duty trucks	> 1,000	7,000
Largest region of operation	National	International
Acquisition types	Mixed	Mixed
Acquisition condition	New	New and used
Medium- and Heavy-duty use cases	Heavy-duty long haul and short haul	Heavy-duty long haul and short haul
Ownership model	Centrally owned	Centrally owned
Operating model	Dedicated	For hire

Both fleets use complex algorithms to synthesize multiple measures in their truck turnover decisions. Fleet 5's Environmental, Social, and Governance (ESG) policies push vehicle acquisitions in the direction of increasing fuel efficiency, experimentation with alternative fuels, and beyond experimentation to incorporate alternative fuels where possible within their vehicle fleet. To the interviewees telling, fleet 5's ability to incorporate alternative fuel—especially electric—trucks is based more on truck availability than the fleet's willingness. Truck retirement decisions are not made solely on the operating history of their trucks, e.g., age, miles, maintenance costs, but by monitoring advances in fuel economy and other performance capabilities of new trucks. If new truck advances are large enough, fleet 5 will accelerate their turnover cycle by retiring and acquiring more trucks; conversely, if new trucks do not provide much performance improvement, fleet 5 will lengthen their fleet turnover cycle.

Fleet 39 manages their fleet turnover according to a total cost of ownership (TCO) model, modified by determinants such as brand loyalty (based on after-acquisition service) and other long, term working relationships. The model has been used to increase their truck turnover rate, i.e., replace trucks sooner; their average truck age has declined from ten to nine years. The model takes data on costs per mile (including fuel cost), reliability (e.g., downtime), resale value, and driver satisfaction. Regarding the latter, the interviewee notes the TCO outputs are calculated “consistently” over the years, but the weight given to driver input varies.

The existence of ESG policies within both fleets is the primary indicator of their proactive approaches to managing their fleets. Both are aware of impending emissions regulations. Both maintain a broad network of industry contacts, searching for information and opportunities to test within their fleets new truck technologies that may keep them compliant with these new requirements.

Both operate in (fleet 5) or as (fleet 39) large, bureaucratically complex organizations. Fleet 5 services the needs of the larger company thus, the truck types (classes and configurations) of trucks it operates depend on input from the product side of the company. The interviewee in fleet 39 claims greater decision-making authority than the interviewee for fleet 5 but does work within a hierarchy in which he receives input from maintenance, drivers, and others closer to the day-to-day truck operations and in which his recommendations for truck acquisitions and retirements require approval up to the level of fleet 39’s chief executive officer (CEO).

The size and complexity of the entities operating fleets 5 and 39 provide the resources and requirements for complex and proactive decision making. This results in truck turnover decision that are made based on complex algorithms that synthesize not only data from within fleet operations but also from outside the fleet, i.e., tracking resale value of their trucks in the used truck market and the changing performance and price characteristics of new trucks.

Case Study 6: Complex, reactive decision making in a hierarchical structure.

This case study draws on Fleets 37 and 58 to illustrate complex, reactive decision making in a hierarchical structure. Their basic operational descriptions are in Table 8.

Fleets 37 and 58 have hierarchical decision-making structures with multiple individuals having different levels of influence over decisions. Fleet 37 has a three-tier hierarchical structure. The company’s owner has the highest authority over purchase decisions, requiring the interviewee (who is the Safety Director and Fleet Manager) to purchase Freightliner Cascadia trucks. The mid-level decision-maker is the Maintenance Director, who works with the interviewee to manage the fleet’s day-to-day purchase decisions. While these two work together to decide which trucks to procure, the Maintenance Director is the one who ultimately signs off on the decision. On this relationship, the interviewee stated,

> *"It's [the owner's] decision to prefer that manufacturer and [the Maintenance Director's and my] duty to keep that going…he simply gives us his recommendations and we vet it out, we do the research, and we confirm it or suggest something different."*

Table 8 Case Study 6: Fleet 37 and 58 Descriptions

	Fleet 37	**Fleet 58**
Number of medium- and heavy-duty trucks	200	250
Largest region of operation	Western U.S.	National
Acquisition types	Purchase	Mixed
Acquisition condition	New	Mixed
Medium- and Heavy-duty use cases	Heady-duty long-haul	Medium-duty delivery
Ownership model	Centrally owned	Centrally owned
Operating model	For-hire	Dedicated

Fleet 58 also has a three-level hierarchy, with the company's CFO at the top. The interviewee (who is the Vice President of the company) is in the middle tier and is responsible for creating an annual plan for truck acquisition and retirement. This plan is created using input from the base tier of branch managers.

Decision-makers in both Fleets 37 and 58 use upfront costs, maintenance costs, warranties, direct cost accounting, dealer loyalty, and manufacturer loyalty as inputs in their acquisition decisions. Fleet 37's primary decision-making criteria is a cost per mile (CPM) metric, derived from a TCO-type analysis. This metric is calculated about once per month using the cost of insurance, maintenance, and labor costs, but not fuel costs "*because it's so volatile.*" Maintenance costs include the cost of in-house labor for maintenance, maintenance relationships with the dealership, and how quickly trucks are become operational again when down for scheduled or unscheduled service. This "total" cost is then divided by the expected truck lifetime mileage (450,000 miles). The owner compares this CPM metric with decision-makers in other fleets he knows and trusts. While the company used to purchase a mix of Volvo, Freightliner, and Kenworth trucks, their CPM metric led them to purchase mostly Freightliner Cascadia's beginning 10 years ago.

The interviewee for Fleet 58 uses a multi-factor scoring as a determinant of truck retirement. Each year, all trucks in the fleet are ranked relative to one another based on metrics such as odometer, maintenance expenditure, age, and usage. Ranks are converted to scores and trucks with the lowest scores are reviewed for possible removal from the fleet while those with high scores are kept. While the interviewee from Fleet 58's personal preference for Ford vehicles influences the company's standard decisions, they recently started purchasing from Chevrolet because Ford , facing supply chain constraints, could not deliver trucks. The interviewee recalled,

> *"I can't get any orders through my company for Fords, we missed the order block, we don't know when the next order block's going to happen. I hear they're having chip issues, nobody can get an F450 to save their life, and lo and behold, GM reached out to me… and in doing so, [the GM representative] starts to answer some of the questions I've been looking for which is 'when are the order blocks happening, how many trucks can they handle, when would they deliver?'"*

While both fleets include warranties in their decision-making, Fleet 37 uses them as an indicator for truck retirement and Fleet 58 uses them to manage their relationship with dealerships.

Decision-makers in Fleet 37 also consider safety, driver resistance, new makes and models, and emissions regulations in their truck purchase decisions. The interviewee mentioned California regulations caused the company to consider purchasing natural gas trucks for their operations in the state. He did not think the company would be prevented from entering the state if they did not make this switch stating,

> *"It will simply just become more expensive to drive in California instead of us being told you can't come. We'll need that permit for X number of pounds of whatever going into the air that is not being prevented because we're not on natural gas."*

Despite this perspective, the interviewee reported looking into acquiring natural gas trucks.

Decision-makers in Fleet 58 work with a fleet management company to help procure vehicles and manage back-office costs because the company's personnel was "*not where they needed to be for the company size."* The fleet management company advises the fleet on truck specifications, manages maintenance costs, and "*technically own[s] the [truck] title, they purchased it for us on our behalf.*" The company stays away from purchasing heavy-duty trucks to avoid the need for drivers with a commercial driver's license (CDL). The interviewee states that warehouse, manufacturing, and driver-employees are, "*very, very hard to find,*" citing annual turnover rates of 15 to 20%. By operating only medium-duty trucks that do not require a CDL, the company is trying to expand their pool of potential drivers.

The high number of metrics used in the decision-making process, along with the elaborate systems of tracking data, cost calculations, and ranking of trucks mean we characterize these companies as having a complex decision-making process.

Although both fleets have begun researching alternative fuel vehicles, they are classified as reactive given their reluctance to invest much time and money into that research or to test them in their fleet. The interviewee for Fleet 37 said they were beginning to investigate alternative fuels but would only really consider trucks offered by Freightliner. The interviewee further stated that they were not considering any specific fuel types, just looking at whatever is available. If the expected CPM of an alternative fuel truck was higher than their current CPM, the owner would not be likely to consider acquiring it,

> *"He's not going to spend money just to change the fuels. He wants to see that it is equal or better in CPM."*

Fleet 58 was further along in their consideration of alternative fuel trucks, having signed a contract to purchase an electric van. This vehicle was purchased for the company's California operations, "*because [the company] gets a $60,000 credit.*" The interviewee further stated,

> *"I don't have to do the credit application myself. I don't have to do the charger myself. Most of these companies [electric truck manufacturers] are nice enough that they're going to go through everything for you and you just have to sign an agreement… I think technically the reason we're doing it is more of a philosophical discussion."*

Both fleets were waiting for an outside source to motivate them to make a change. This leads them to be categorized as reactive decision-makers.

Fleet 37 and 58's organizational structure gives different weight to each person's input, creating a hierarchical structure. The large number of metrics and elaborate calculations create a complex decision-making process. Finally, their reliance on outside motivations as a catalyst for change categorizes them as reactive.

Case Study 7: Complex, proactive, and siloed decision making.

This case study draws on Fleets 1 and 12 to illustrate complex, proactive, and siloed decision making. Their basic operational descriptions are in Table 9.

While both fleet 1 and 12 are mid- to large-size, centrally owned fleets operating on a for-hire basis across the country, they have distinctly different company structures. Yet they both make complex, multi-faceted decisions affecting their fleet turnovers, manage their fleets in anticipation of external forces and future events. The also share a siloed decision-making structure—different people in the organization appear to have sole responsibility for different aspects of truck acquisition and retirement decisions.

Table 9 Case Study 7: Fleet 1 and 12 Descriptions

	Fleet 1	**Fleet 12**
Number of medium- and heavy-duty trucks	70	Variable, but about 200
Largest region of operation	National	Multi-state
Acquisition types	Purchase	Purchase and Lease
Acquisition condition	New and used	New
Medium- and Heavy-duty use cases	Long-haul, short-haul	Long-haul, short-haul, drayage
Ownership model	Centrally owned	Centrally owned
Operating model	For hire	For hire

Fleet 1 primarily provides for hire, long-haul freight service across the country in class 8 trucks. The company is family owned. The principal decision makers have a strong commitment to increasing the fuel efficiency of their trucks and proving to others that meaningful improvements are possible. They have engaged in multi-year projects with multiple truck manufacturers to create high efficiency truck specifications. These have brought them to work with, and acquire vehicles from, a single manufacturer. This approach led them to experiment with a hybrid diesel-propane engine (abandoned because though fuel efficient, it was too expensive) and to a present interest in hybrid diesel-electric trucks.

This drive to high fuel efficiency is balanced against two aspects of driver behavior and satisfaction. Fleet 1's principals don't believe drivers are motivated to drive in fuel economical ways because they are all paid by the mile. This means they drive fast, and the high fuel economy specifications produced by Fleet 1 must reflect this. Because it is difficult to find and retain drivers, whatever else a truck specification accomplishes, it must keep drivers satisfied. Truck acquisition and retirement decisions also account for potential (for acquisitions) and actual (for retirements) resale values. As actual resale values are also affected by maintenance regimes, these costs are also closely tracked and included in turnover decisions.

Fleet 12 is hierarchically organized as one central company overseeing six regional operations covering several states and major US seaports. While the entity operating Fleet 12 owns about 200 trucks of its own, it also contracts with more than 500 other smaller freight carriers. Fleet 12 exerts no control over the trucks of its contractors. Fleet 12 runs a driver training program in part because driving in drayage applications can take both a greater proficiency maneuvering large trucks in confined spaces and specialize knowledge of individual ports.

Several determinants are part of Fleet 12's own vehicle turnover decisions: purchase price, after-sales service, maintenance costs, reliability, e.g., downtime, and availability of alternative fuels—all with consideration for whether the intended application is long-haul, short-haul, or drayage. At the time of the interview, Fleet 12 notes their normal fleet turnover is strongly affected by COVID-19 related supply chain issues resulting in very long wait times for new trucks. For the time being, their truck "specifications" have been broadened to allow Fleet 12 to acquire trucks that were available irrespective of Fleet 12's prior preferred specifications.

Whether due to personal interest of the fleet principals (Fleet 1) or the influence of requirements for cleaner trucks as ports (Fleet 12), both fleets profess a forward-looking truck acquisition process based on being prepared to meet future emissions regulations. Fleet 12 presently has some CNG, battery electric, and FCETs in its regional southern California operation. Acknowledging they were pushed to incorporate these trucks into their fleet by requirements at the San Pedro Bay ports, they did acquire the trucks ahead of the required time to assure the trucks successful use.

Siloed decision making is characterized by different decision makers in a company controlling different aspects of the same truck acquisition or retirement decision. In the case of Fleet 1, the interviewee has sole responsibility for what trucks to acquire while the other company principal—his sister—has sole control over whether that truck will be purchased or leased. In the case of Fleet 12, the central company creates the truck specifications for all trucks acquired by the six regional operations. However, these specifications are general: automatic transmissions, driver comfort features, safety features, etc. Each regional operation makes its own decisions about manufacturer and whether to buy or lease.

Case Study 8: Simple, proactive decision making by a sole decision maker.
This case study draws on Fleets 27 and 31 to exemplify simple, proactive decision making in a sole decision maker structure. Their basic operational descriptions are in Table 10. Their nominal descriptions are very similar; the difference is in their decision about whether to buy new and/or used trucks and how to structure those acquisitions, i.e., as purchases or leases.

Table 10 Case Study 8: Fleet 27 and 31 Descriptions

	Fleet 27	**Fleet 31**
Number of medium- and heavy-duty trucks	1	1
Largest region of operation	National	National
Acquisition types	Purchase	Lease
Acquisition condition	New and used	New
Medium- and Heavy-duty use cases	Long-haul	Long-haul
Ownership model	Driver-Owner	Driver-Owner
Operating model	For hire	For hire

As owner-operators of a single truck, the principals of Fleets 27 and 31 are the sole decision makers about all their "fleet" operations including truck acquisition and retirement. However, Fleet 31 is so constrained by external forces that his initial truck acquisition was all but made for him by the truck leasing company from which he acquired his truck. This status as a "sole-hierarchical" decision type—with the fleet at the bottom of the hierarchy with the leasing company above—is a temporary status unlikely to carry on in the future.

These two fleets provide examples of simple decision making even as they are keeping detailed records of costs; even given ample data, these data are not combined via any complex algorithm. Rather a few key indicators drive truck acquisition and (imagined) retirement actions. (Both have imagined retirement actions as they are presently driving their first truck.)

Fleet 27 is presently providing for-hire long-haul freight services using a 2010 Volvo class 8 truck he purchased as used in 2011. He specifically bought a 2010 model year because he knew it would remain compliant with emissions regulations—likely for the life of the truck. As of the first half of 2022, he had accumulated over 1 million miles in the truck; he believes he can achieve 2 million miles.

As the owner-operator of Fleet 27 looks forward to another truck, he expresses a clear and simple hierarchy of determinants. First is fuel economy, including aerodynamic treatments, because *"they pay for themselves many times over, often within the first year."* This leads him to limit the potential brands to Volvo and Freightliner. Second, he believes the Volvo brand has a better reputation for *"durability, reliability, and uptime."* Thus, without conducting a single calculation or actively shopping for a new truck, he has decided what truck he'll buy next—the highest fuel-economy Volvo he can buy. Third, additional specifications of such a truck would be driven by additional considerations for driver comfort and convenience.

His determinants for when this new truck might be purchased are 1) based on the ongoing records of maintenance and fuel expenditures in his present truck and how those compare to the cost of a new truck, or 2) should reliability of his present truck become an issue. Note that even if the first requires summation of costs across a couple categories, it is well short of an algorithmically complete total cost analysis.

The owner-operator of Fleet 31 also drives a class 8 truck providing long haul service. He was much more constrained than fleet 27 by circumstance in acquiring his first truck, i.e., there were no determinants that were under his control so he acquired what he could if not what he may have wanted. He is new to driving heavy-duty trucks. He completed an 18-moonth stint as a company driver then branched out on his own. However, as a new owner-operator with limited credit history he was unable to buy a truck and had to select a truck leasing company who focused less on credit scores. The lessor nominally offered the truck he had learned to drive (Peterbilt) as well as Volvo. Though he believes he would prefer a Volvo for his next truck, supply constraints meant he would have had to wait even longer for a Volvo than he waited for the Peterbilt (3½ months). The Peterbilt was the truck in which he trained, it was offered by a lessor willing to lease him a truck, and it was relatively more available.

As does Fleet 27, Fleet 31 keeps detailed records of his operating costs including details such as the fuel price discount he gets each time he fuels for having enrolled with a third-party logistics company. Based on his record keeping, he has calculated a price-per-mile threshold he must exceed to be profitable.

Despite this level of detail, his imagination of a future truck acquisition still comes down to personal history and brand reputation. Because his leasing company requires all its trucks to be equipped with extensive safety upgrades (*"You get them all [safety features] or you don't get a truck from them")* he is ingraining safety as a determinant. His calculations show him how important fuel economy is to his fuel costs, so fuel economy is a determinant. However, he does not frame these as elements to be combined into a single metric to be compared to a variety of new trucks. Rather, he describes this future acquisition as short sequence of if-then propositions. If his current truck continues to perform well, e.g., maintenance costs remain low, and a Volvo is not readily available, he will exercise his option at the end of the lease to buy the Peterbilt. If a Volvo is available, he will lease a Volvo tractor and then purchase it at the end of that lease. He would prefer to buy than lease because the monthly payments are lower—but offers this without considering additional services, e.g., maintenance, that could be included in a lease.

Fleets' 27 and 31 adaptation is a subtle form of proactive: if not exactly formulating and enacting plans in the face of future contingencies they are active information seekers searching for best practices, monitoring their own ongoing flows of truck and cost data. These two fleets share an outward vision that solicits information and experience outside their own operations. Fleet 27 has participated in test drive programs with truck manufacturers, particularly Volvo. Fleet 31 avidly searches for information across social media and from his peers.

As truck owner-operators, Fleet 27 is, and Fleet 31 aspires to be, a sole decision maker. Both these fleets emphasize the role of fuel economy in their truck acquisition (and in the case of Fleet 27, subsequent modification with aftermarket aerodynamic treatments and driving style). Other operating costs, especially maintenance, play a role truck retirement. As owner-operators these are costs they see—if in part because both fastidiously track these costs for trucks of which they have direct daily experience.

Case Study 9: Simple, reactive decision-making by a sole decision-maker.
This case study draws on Fleets 19 and 30 to illustrate simple, reactive decision-making in a sole structure. Their basic operational description is in Table 11.

Table 11 Case Study 9: Fleet 19 and 30 Descriptions

	Fleet 19	Fleet 30
Number of medium- and heavy-duty trucks	40	1
Largest region of operation	Southern California	National
Acquisition types	Mixed	Purchase
Acquisition condition	Used	Used
Medium- and Heavy-duty use cases	Medium-duty delivery Heavy-duty drayage	Long-haul
Ownership model	Mixed	Driver-owner
Operating model	For-hire	For-hire

Fleet 19 is a single-owner fleet offering local delivery service in southern CA including drayage at the Port of Los Angeles. Their total fleet (including two light-duty delivery vans) consists of 42 used vehicles: 22 medium- to heavy-duty box trucks and 18 class 8 tractors. Fleet 19 truck acquisition and retirement decisions are made by a single individual, the owner of the company. Fleet 30 is a long-haul, single-truck owner-operator who moves general goods. A driver for 7 years and owner-operator for 3.5 years, he bought a used model year 2012 truck in 2017.

Fleet 19 relies on experience, judgment, and *"common sense"* when choosing a truck. Few determinants are given consideration in truck acquisitions. Instead, Fleet 19 favors truck models and engines they've had *"good luck"* with in the past (meaning relatively few repair issues). They pay an individual to help find used trucks on the for them. As part of the purchase process, Fleet 19 checks a list published online by the California Air Resources Board to see what vintage trucks are prohibited due to emission regulations from operating in California. They started checking this online list because every year they have old trucks that *"CARB out"* (become ineligible for operation in California because of emission regulations). Recently, Fleet 19 began leasing a single truck to determine if it is a viable, cost-effective option.

Fleet 19 has a very simple approach to determining truck service life. Reasons given for retiring a truck are *"CARBing out"* or repair costs more than what the owner feels is worth fixing (for example, an engine or transmission overhaul). If they think they can get money selling a used vehicle they will do so, otherwise they scrap it after stripping it of parts to repair other trucks.

Fleet 30 relies heavily on social media including Facebook groups to guide truck purchases; a podcast has also proven to be an import source for his truck purchase. Recommendations from the podcast helped him understand what to look for in a used truck and where to find one. Fleet 30 started his truck search with a short list of features he wanted in a truck: an APU, a sleeper, good horsepower, and a refrigerator. He also wanted reasonably low miles; the truck he purchased had 589,000 miles. He shopped online and at dealerships until he found the right truck (which was purchased at a dealership recommended by the podcast). Fuel economy is important to Fleet 30 but is addressed through after-market products including aerodynamic retrofits, fuel additives, an oil bypass system, and narrow tires. Again, he learned of these technologies through the podcast. Fleet 30 also made sure that his truck was *"CARB compliant"* at the time of purchase.

Fleet 30 relies heavily on Landstar, a fleet management company, to keep a repair/maintenance schedule, load insurance and fuel cost. He also financed the purchase of a trailer through Landstar because of timing and convenience. He will probably stick with Volvo for his next purchase because, unlike other trucks he has driven, Volvo has a steering wheel airbag. He also has a good relationship with the Volvo mechanics and likes the aerodynamic shape of Volvo trucks.

Both Fleet 19 and 30 tend to react to external factors regarding truck purchase and retirement. For example, Fleet 19 found out they could not operate certain trucks in California only when they were unable to renew the registration. The truck turnover rate of Fleet 19 is determined by collisions, major breakdowns or other damages deemed too costly to repair. Likewise Fleet 30 was dependent on market availability when searching for a truck that best fit the driver's needs. Fuel economy is important to Fleet 30, but it is addressed post-purchase with aftermarket add-ons rather than being a primary criterion in the purchase process.

These two fleets illustrate simple, reactive decision making within a sole decision structure. Simple evaluations and heuristics are used to determine vehicle turnover. The two fleets share a few determinants, but utilization of those determinants is very simplistic. In both fleets, purchase and retirement decisions are made by a single individual and, therefore, do not require levels of authority. This allows decisions to be made quickly and purchase criteria can be easily adapted to accommodate changes in external factors. One of the most significant of those factors is CARB regulations that disallow specific model year trucks to operate in California.

Case Study 10: Complex, proactive decision making by a sole decision maker

This case study draws on Fleets 16 and 33 to illustrate complex, proactive decision making by a sole decision maker. Their basic operational descriptions are in Table 12.

Fleet 16's interviewee is the CEO of the company while Fleet 33's interviewee is the General Manager who does, "*all of [the] truck and trailer purchasing and selling*." When asked whether anyone else in the organization is involved in the purchase decision, the fleet 33 interviewee stated,

> *"I mean, I get some feedback from them, but as far as just whenever it comes time [to acquire or retire a truck]...I just make the decisions."*

Both interviewees say they use fuel economy, maintenance costs, resale value, safety, driver retention, manufacturer loyalty, and emissions regulations as determinants in their acquisition decisions. Better fuel economy, cheaper maintenance costs, and the familiarity of their in-house maintenance teams with Volvo and Freightliner trucks lead the interviewee from Fleet 16 to prefer these brands. The interviewee uses safety, driver retention, and resale value as considerations in his retirement decisions stating,

> *"We want to operate as safe as possible; we want to let the drivers know that we're not going to keep trucks longer than we should."*

Fleet 16 resells their vehicles off their lot to maximize resale value and avoid low values created by an unpredictable resale market.

Table 12 Case Study 10: Fleet 16 and 33 Descriptions

	Fleet 16	Fleet 33
Number of medium- and heavy-duty trucks	55	180
Largest region of operation	Southern California	National
Acquisition types	Purchase	Purchase
Acquisition condition	New	New
Medium- and Heavy-duty use cases	Heavy-duty drayage	Heavy-duty long-haul
Ownership model	Centrally owned	Mixed
Operating model	For-hire	For-hire

The interviewee for Fleet 33 does not restrict his purchases to any specific brands but developed a standard truck specification that is used to gather quotes from *"everybody."* These bids are evaluated based on purchase price, fuel economy, safety, resale value, and maintenance costs. Bidding allows the interviewee to negotiate a better purchase price and warranty for the trucks. While they have purchased other brands in the past, the interviewee currently only purchases Freightliner trucks because drivers prefer them, and their in-house maintenance is certified to do warranty work on Freightliner trucks (the dealer pays the company for parts and labor hours spent on these repairs).

Both fleets account for many determinants involving detailed data collection and analysis in their purchase decisions. Fleet 16 keeps detailed records of maintenance and operating costs which are used to identify trucks with higher operating costs so they can be removed from the fleet. The interviewee mentioned they still have 2010 model year trucks running while 2015 model year trucks are being retired because they have higher operating costs. Fleet 33 utilizes an automatic fuel tracking system and has a maintenance manager who tracks the maintenance costs of trucks. These data-driven systems help inform the complex decision-making of Fleets 16 and 33.

These fleets are characterized as proactive because they have actively sought out and used new technologies before they were required to do so. Despite Fleet 16's interviewee's insistence that, "*without a regulation, we're still going to continue to operate our diesel tractors*," the company has participated in an electric truck demonstration project and currently operates 18 CNG trucks under a Prop. 1B grant. The interviewee has plans to expand the number of CNG trucks in the fleet. Fleet 33 does not have experience operating alternative fuel trucks but has purchased electric auxiliary power units and multiple types of aerodynamic technologies. They run their own experiments to understand the fuel saving potential of each:

> *"…two years ago, what I did is I had 30 company trucks coming in…I put 10 of them with no wheel covers on or anything, I put 10 in that fleet that had just wheel covers, and then I put 10 in the fleet that have wheel covers and wheel closeouts…and I just ran a comparison on those 30 trucks and that's how I figured my fuel mileage out…"*

The propensity of fleets 16 and 33 to try new technologies identifies them as proactive decision-makers. The interviewees' willingness to make decisions without the requirement for input or authorization from elsewhere in their organizations typify a sole decision-making structure. Finally, their use of many inputs in truck acquisition and retirement decisions, along with the tracking and use of quantitative data characterizes these fleets' decision-making as complex.

General Effects across Fleets

Analysis of the fleet interviews leads to generalizations common across many fleets. These generalizations are discussed below along with the effect on truck acquisition or retirement decisions. While some of these have been discussed in relation to specific fleets in the Determinants section, here we emphasize results across several fleets.

Discussion of total-cost-of-ownership (TCO)

Total cost of ownership may be an analytically useful approach in program and policy analysis, but it should not be confused with a general description of how fleets make truck acquisition and retirement decisions. As described in the literature review, many analyses by researchers and regulatory agencies are based on truck TCO calculations. However, unprompted most small- and medium-size fleets interviewed for this study did not mention such analyses in describing their own decision-making. When prompted by interviewers for the possible use of any analysis like a TCO calculation, most interviewees indicated a TCO calculation is either not a significant determinant or not a determinant at all in their truck turnover decisions. In some cases, fleets mentioned keeping data on maintenance or fuel costs but not using those data in calculations of total costs. Other fleets mentioned giving their data to third parties to conduct a TCO-like analysis but did not specify how those results were utilized in truck acquisition or retirement decisions. Some fleets clearly indicated that they did not use anything like a TCO calculation. Some smaller fleets do consider TCO to be an important determinant in decision making, and those fleets collect relevant data and either conduct their own TCO calculations or contract with outside consultants to do so.

In contrast, all the large fleets interviewed for this study including leasing companies mention TCO analysis. These companies specifically called out detailed data inputs for analyzing total cost. These fleets have many trucks in many applications often from multiple manufacturers. Unlike small or many medium size fleets, large fleets have the personnel to acquire data, input data into cost programs, conduct analyses, and report results to relevant decision makers.

Increased use of leasing companies

In acquiring trucks, fleets have several options. They can purchase trucks either new or used, lease trucks, or rent trucks. Many fleets stated that they lease some or all their vehicles, and interviewees generally indicated they expected leasing to become more common over time.

There are several reasons fleets choose to lease trucks.

- Limited cash flow may cause some fleets that cannot afford to purchase the trucks they desire to lease instead. If cash constrained a fleet that considers operating newer trucks to be important may only have the option to lease.
- Leasing shifts many costs—financial, human resource, property, and others—of owning and operating trucks to a leasing company. Owning trucks requires a fleet to make a variety of decisions that can be time consuming and complicated including purchasing, maintaining, and retiring trucks. Leasing eliminates the uncertainty of truck maintenance costs and the decision of where to do maintenance. Furthermore, retiring the truck is, in general, determined by the duration of the lease (which may include a mileage cap). Lease terms can include varying options such as rental truck inclusions, the ability to fully specify the truck, full service versus lower-level service options, and replacement trucks while a leased truck is under repair.
- Truck technology is becoming more complex and maintenance more difficult. Some fleets prefer to leave evaluating new technologies and all maintenance to leasing companies. As complexity continues to increase, the pressure to move to leasing is also likely to prompt more fleets to shift from purchasing to leasing trucks.

Variation in importance of fuel economy

Fuel and labor costs are often the two largest truck costs for fleets. Since increased fuel economy reduces fuel costs, one might expect all fleets would view fuel economy as a critical aspect of their operations. In fact, across the interviewees we heard broad variability in the importance of fuel economy.

Some fleets explicitly stated they do not keep fuel economy data and do not consider fuel economy in any decision making. Other fleets mentioned fuel economy as a determinant but did not seem to stress its importance, giving other determinants significantly more weight. Some fleets, especially large ones, did acquire detailed data on fuel economy, and used that data in their TCO analyses. Fleets may work very closely with a truck manufacturer to develop technology to increase fuel economy without significantly increasing the truck acquisition cost. Many fleets reported that the variation in fuel economy from manufacturer to manufacturer is minimal and thus there was no advantage to be gained from devoting resources considering fuel economy. Some fleets said they did not trust manufacturer estimates to apply to their use conditions. Part of this is the practice of testing the fuel use of engines, not drivetrains, which does not transfer to all truck specifications into which that engine is installed. Further, some fleets argue variable driving conditions, especially speed, contribute significantly more to fuel use variation than the nominal fuel economy of the truck.

Brand loyalty

Several fleets stated brand loyalty is a major determinant in their acquisition decision. Essentially when these fleets acquire a new truck, they always acquire it from the same manufacturer. The loyalty is developed over a period during which the ultimate decision maker(s) in the fleet determine a particular truck best suits their needs. Some examples of the rationale given for this brand loyalty are:

- Development of a working relationship. The fleet has acquired trucks from the manufacturer over some number of years, and the fleet feels the manufacturer has treated them well and sometimes given them special treatment.
- Experience has indicated the manufacturer's trucks are more reliable than another's.
- Problems with other manufacturers. The fleet has experienced problems with a particular manufacturer's trucks and has transitioned to a new supplier. The experience with the new manufacturer remains better than the former one, so the fleet essentially switches loyalty.

In some cases, the loyalty is so strong that the main decision maker will simply overrule all suggestions to try another manufacturer. Sometimes a fleet will hire a new decision maker who switches the fleet to their manufacturer of choice.

Prevalence of maintenance as a determinant

While most fleets do not use TCO calculations and few use fuel costs, most fleets do mention maintenance as an important decision determinant especially for truck retirement decisions. Fleets generally keep maintenance records even if they are not very detailed, and they are aware of trucks that have significant repairs or are out-of-service more often and/or longer than expected. Maintenance is often used as a stand-alone determinant in retirement decisions and as a contributing determinant in acquisition decisions.

Many fleets will typically use either a fixed mileage or excessive maintenance incidence or cost to indicate when to retire a truck. For those who do not use mileage, maintenance costs or downtime may determine truck retirement. Sometimes a fleet will compare maintenance costs with the truck's depreciated value and decide to retire or not based on that comparison. More often fleets report they use maintenance in a semi-quantitative manner. When the truck seems to be too expensive to continue repairing, they retire it.

Impact of driver shortage

Fleets indicated there has been a driver shortage for the past few years. The COVID-19 pandemic contributed to this shortage during the study period. Fleets often stated drivers are their most valuable asset and these fleets consider feedback from their drivers when making decisions about truck acquisitions. Hiring and retaining drivers can be difficult, so fleets will act to retain drivers; operating newer trucks is one strategy to do so. Some effects of this driver shortage on acquisition and retirement decisions are:

- Turn trucks over more quickly as drivers prefer newer trucks.
- Acquire specific truck classes. Fleets may attempt to operate only medium-duty trucks—even in long-haul applications—to avoid requiring drivers to have commercial drivers' licenses (CDLs). The labor rate for drivers with a CDL is higher, and those drivers are more difficult to find, hire, and retain.
- Acquire trucks with additional safety features. Safety is often mentioned as a key concern for fleets, and safer trucks are believed by some fleet decision makers to retain drivers longer.
- Limit fleet size. Fleets may wish to expand, but the driver shortage constrains their ability to operate more trucks.

Episodic Events

Specific events can have major effects on the trucking industry. Recently the COVID-19 pandemic created problems with the manufacturing supply chain and with the number of available drivers. New truck deliveries were delayed for months—sometimes exceeding a year. Closure of truck driver schools reduced the number of new drivers. Some fleets, e.g., those hauling refined transportation fuels, saw sharp declines in demand for their services while fleets delivering food items and consumer goods—to stores and to homes—saw increases. All fleets talked about adjusting to the changes via various strategies.

Fleets were forced to acquire trucks that were available rather than specifying exactly what they wished. Larger fleets order more trucks and get preferential treatment from manufacturers and dealers. Smaller fleets are left to select from what is left. In some cases, fleets were forced to change their normal purchasing procedures, e.g., switching to leasing or from used to new trucks or new to used. Some fleets saw the demand for their services increase due to the pandemic, but their normal responses to increase trucks and drivers were hampered because acquiring additional trucks and hiring and retaining drivers were harder.

Regulation

Regulation significantly affects fleet acquisition and retirement decisions in a variety of ways. In some cases, fleets are forced to adjust to the new regulation by changing their fleet composition. In other cases, fleets may attempt to delay such changes by holding on to their trucks longer.

- Port specific policies. Fleets mentioned turning their fleet over faster to meet the California port requirements, and they expect to do so again in the near- to mid-term.
- AB-5. The change in the status of independent contractors may require fleets to convert contract drivers to employees. In doing so fleets may have to change the number of trucks they own. Some fleets suggested independent drivers may leave the state because they do not wish to be employees.
- Financial Accounting Standards Board (FASB) rules on truck leases. Some companies report changes to how they must report truck leases caused them to switch from lease to purchase. However, as the new FASB rules are just coming into effect, their eventual effect on the balance between purchasing and leasing trucks is not yet known.

Consideration of Alternative Fuel Trucks

Decisions to acquire alternative fuel trucks (AFVs) presently differ from those for trucks running on diesel and gasoline. AFV acquisition decisions include weighing positive and negative determinants of AFVs compared to diesel trucks including physical attributes of the trucks, costs, fueling infrastructure, regulations, and incentives. Determinants described by our interviewees as positively influencing their decisions are discussed as motivations or benefits to acquiring AFVs; determinants negatively associated with AFVs are discussed as barriers or obstacles.

The results of this section draw from the first 29 interviews. This includes eight fleets who have current or previous experience operating battery electric trucks (BETs), three fleets who have current or previous experience operating fuel cell electric trucks (FCETs), and 11 fleets who have current or previous experience operating natural gas trucks (NGTs), including compressed natural gas (CNG) and liquefied natural gas (LNG). Alternative fuels that are currently or previously used in each of the 29 fleets are shown in Table 13.

Table 13 Fleet Experience of Alternative Fuel Trucks, subset of fleets used for alternative fuels analysis

Interview Number*	Battery Electric Trucks (BETs)	Fuel Cell Electric Trucks (FCETs)	Natural Gas Trucks (NGTs)
1			
2			
3			
4			
5	X		X
8			
12	X	X	X
13	X		X
14	X	X	X
15			X
16	X		X
17			
18	X		
19			
21			X
22	X		X
23			
24			X
25			X
26			
27			
28			
29			
30			
31			
32			
33			
34			
35	X	X	X

* Interview numbering is non-sequential and goes higher than 29 as interviews conducted with consultants, manufacturers, and dealers are not included in this discussion.

Determinants mentioned by one or more of these fleets are discussed below and ranked based on the number of fleets mentioning them. The prevalence of determinants across the sample is used here to establish the order in which determinants are presented. These rankings should not be taken to be representative of the medium- and heavy-duty fleet population nor to indicate which barriers have the largest influence. Prevalence in the sample may indicate the level of attention currently given to certain determinants of specific alternative fuels. This may change over time if specific AFVs are offered in relevant weight classes or use cases, as fleets talk to different fleets, or even as people within a single fleet talk amongst themselves about changing possibilities to acquire and use AFVs.

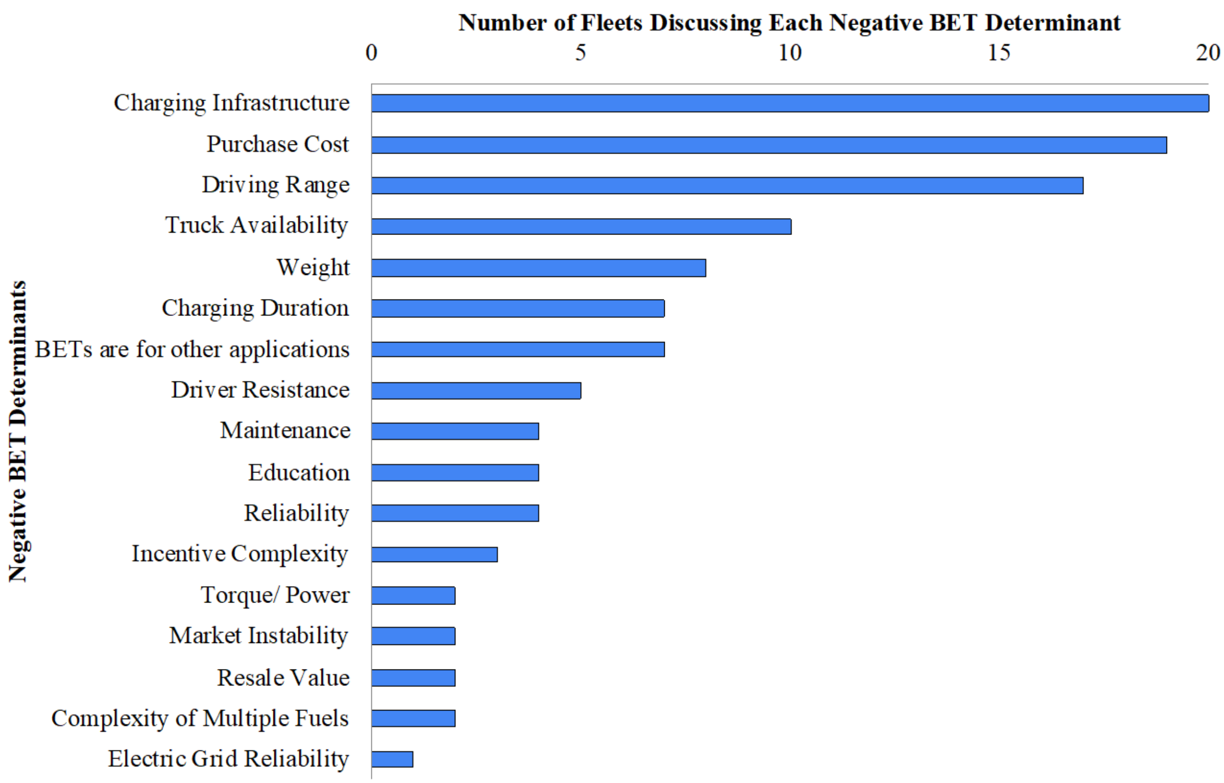
Each determinant is presented as it is discussed by the interviewees based on their understanding and interpretations. That is, for better or worse, what follows are not necessarily statements of facts about AVFs but are statements of the perceptions of AFVs by the interviewees. The order of presentation is battery electric trucks (BETs), fuel cell electric trucks (FCETs), and natural gas trucks (NGTs).

Battery Electric Trucks

Barriers or negative determinants

These fleets discussed 17 different barriers to incorporating BETs into their fleet operations. The distribution of the number of mentions of each barrier is illustrated in Figure 16. In this sub-sample, five out of the eight fleets with experience operating a BET did so as part of demonstration projects funded by a truck manufacturer, leasing company, or government grants. Only three fleets had purchased an electric truck without such financial support.

Figure 16 Determinants against Battery Electric Trucks



Charging Infrastructure was the most reported obstacle to BETs among this subset of interviews. This includes a lack of publicly available charging infrastructure and costs and complications of installing privately-owned charging stations on a fleet's property. Interviewees reported public charging infrastructure as almost non-existent, making it impossible to charge trucks that do not return to a depot every night. While particularly a concern for long-haul fleets, some trucks that return to a central location are still seen as incompatible with BETs as they would be stranded if they ran out of charge away from the depot.

A higher **purchase price** for BETs relative to diesel and gasoline-fueled trucks was the second most discussed barrier. High purchase prices were cited as a primary barrier by both fleets with and fleets without electric truck experience. Interviewees mentioned their companies are unable to pass on higher costs to their customers. The company would therefore have to internalize the cost, possibly putting them into debt. Others mentioned they expect electric truck purchase prices to decline significantly; they were waiting for this to happen.

Driving Range was the third most mentioned barrier, i.e., the limited range of electric trucks per charge compared to the distances conventionally fueled trucks travel per refueling. Interviewees in our sample report driving their trucks, particularly class 8 trucks in long-haul applications, up to more than 700 miles per day. Range concerns, however, were not limited to fleets operating in the long-haul sector but include those in short-haul and drayage, too. While most interviewees focused on the restrictions posed by the manufacturer's reported maximum expected range for presently available BETs, others cited concerns about the impact of battery degradation and temperature on this maximum range. The interviewee from Fleet 02 reported, "*…it's going to be minus 10 tonight. Batteries, they just can't handle that right now.*"

Lack of **Truck Availability** was the fourth most frequently cited barrier. This includes the unavailability of trucks in certain weight classes, lengths, and model types (e.g., box trucks or sleeper cabs). This barrier was particularly a concern for fleets with strict truck specifications as electric truck models were often unable to meet these specifications. One interviewee mentioned that the available BET models had a longer wheelbase than their current trucks, creating larger turning radii and limiting the driver's ability to deliver in physically constrained areas, e.g., ports and dense urban areas.

Vehicle Weight was the fifth mostly frequently cited barrier. Given restrictions of gross vehicle weight on all trucks, the increased weight of an unloaded electric truck in comparison to that of an unloaded diesel truck limits the weight of each truck load. Interviewees commonly mentioned they already load trucks to or near the weight limit of whatever weight class they use. The increased unladen weight of BETs would therefore limit the revenue-earning freight the fleet could move per truck. One interviewee operating Class 8 trucks mentioned that natural gas and electric trucks are allowed to exceed the federal weight class limits by 2,000 pounds. However, they did not see this as fully covering the unloaded weight penalty of BETs.

Charging Duration was the sixth most frequently cited barrier. It is related to the much longer length of time required to charge an electric truck compared to the time needed to refuel a gasoline or diesel truck. Interviewees felt charging times should fit their current operating schedules. This might require mid-shift charging occurring during the one or two mandated 15-to-30-minute breaks for drivers. While overnight charging was seen as a potential solution for some fleets, others reported having trucks operating two shifts per day. Trucks running two shifts might have four hours or less per day to charge. Interviewees did not believe this would allow enough charging time to support their operations.

The belief that BETs were better suited for **Other Applications** than the reporting fleet was the seventh most common barrier mentioned by the interviewees. This means that the interviewee, the organization, or the truck application was seen as incompatible with electrification, thus relieving them of the responsibility of incorporating BETs into their fleet. This negative determinant was stated by fleets of all sizes and applications (e.g., long-haul, short-haul, and drayage). Interviewees pointed to fleets operating over smaller regions, in urban areas, and in areas with the worst air quality as being responsible for demonstrating BET feasibility.

Driver resistance is the interviewees' perception of an unwillingness by drivers in their fleet to use BETs. Fleets mentioned driver-shortages as an industry-wide concern, increasing competition amongst companies to recruit and retain drivers. Interviewees felt that if they were unable to keep their drivers happy, they may leave, limiting the company's ability to do business. Drivers were seen as resistant to change of any type, and if they are forced to drive a BET, they may leave the company or truck driving altogether.

Maintenance was the eighth most mentioned barrier. This included deviations from the fleet's current maintenance costs or structures caused by BETs. Interviewees reported concerns over the battery longevity and the inability of present mechanics to service BETs. Batteries were thought to have an estimated life of five to eight years, with factors such as fast charging, weather, and demanding duty cycles leading to battery degradation requiring more frequent replacement. If a fleet operates its own maintenance facilities, then perceived unfamiliarity of the company's current maintenance team with BETs also prevented adoption as interviewees felt they may need to close their maintenance shops entirely.

Education, the ninth most mentioned barrier, refers to need to overcome a lack of knowledge about new technologies or regulations, whether referring to the interviewee's own lack of knowledge or regarding the trucking industry in general. One interviewee mentioned the trucking industry tends to view all environmental policies negatively, causing people to resist rather than try to understand how to comply. A perception of constantly changing technologies and regulations makes it difficult for fleets to keep up, increasing their time to research new technology (beyond those they are required to adopt). Lack of education was seen as a particular concern for smaller fleets who may lack the personnel required to track regulatory changes. One interviewee discussed their own lack of knowledge about BETs, stating,

> *"It's been a challenge…I know a lot about internal combustion engines and how they work…but once you start taking about electric, I have no idea what I'm doing" (Fleet 17).*

BET **Reliability,** including the ability to reliably complete routes, was seen as unproven. Reliability is a different barrier to completing existing routes than driving range, charging duration, and vehicle weight. Here, concerns about BETs' ability to, among other things, maintain temperature integrity when hauling refrigerated freight. Other fleets felt that if an electric truck were to break down while on its route, the driver could be left in an unsafe situation and be unable to complete their job. This concern came from interviewee's uncertainty about the new technology and concerns that BETs may be more likely to break down than diesel trucks. This led to concerns that customers would,

> *"…find somebody who can [complete the job]… they will vote with their feet, and they will move on to someone that can service them" (Fleet 03).*

Each of the remaining barriers to BETs were mentioned by three or fewer fleets.

Complexity of applying for and participating in incentive and demonstration programs was described as discouraging fleet participation. This includes issues applying for or complying with the requirements of grant and incentive programs. Some interviewees felt incentive program deadlines were too short and restrictive given BETs can take a year or more to arrive after they are ordered. This can make it impossible for the fleet to procure a BET within a required time. Another interviewee noted their electric utility would only begin working with them once they committed to purchasing BETs but grants to purchase BETs were set to expire before the trucks are available. The misalignment of incentive deadlines and requirements left the interviewee feeling overwhelmed. Others noted that while grant programs could provide up to $80,000 for the purchase of a BET, this would not reduce the cost of a BET enough to make them a viable choice for the fleet.

Torque and Power of BETs raised concerns with a few fleets, including the belief, by at least one fleet that BETs have too much torque/power and the belief by other fleets BETs may not be able to maintain their torque/power over extended periods of time (where power is understood to be energy over time). An interviewee from a fleet that transports chemicals felt that BETs had too much torque, creating a safety hazard. The fleet had participated in a demonstration program, during which the drivers reported feeling unsafe with how the swift acceleration pulled the cargo around. Despite sending the vehicle back to the manufacturer to adjust the torque, the issue was not fully resolved, and the truck was removed from the fleet. Conversely, another interviewee reported hearing BETs have more power than diesel trucks but was concerned the trucks would not be able to sustain this over their whole duty cycle.

Market Instability because of perceived or anticipated frequent regulation changes was noted by a couple fleets as a barrier to their acquisition of BETs. Fleets who previously purchased CNG trucks felt that they were being punished and their investment had been wasted given they were now being forced to switch to electric. This led to concerns that a similar change could occur if they are early adopters of BETs. The interviewee for Fleet 11 expressed this concern saying,

> *"We have a $3.5 million CNG slow fill station out there that within 10 years may be obsolete because all those vehicles need to be electric. If we invest millions of dollars in electrical infrastructure, who's to say in 10 years whether that may not become out modeled in some way?" (Fleet 11).*

As **Resale Valu**e has not been established for BETs, this was a concern for a couple fleets. Some interviewees report using resale value as a part of their overall truck cost calculations. One fleet felt that the market for used BETs is limited or nonexistent, impacting the trucks lifecycle costs. When approaching a bank about financing a BET, another fleet found the bank was unable to determine the residual value of the truck, which is used in determining finance rates. While the interviewee was able to reach an agreement with the bank, they felt other fleets would be impacted by this issue when they try to finance a BET.

Complexity of multiple fuels were raised by an interviewee regarding their ability to manage different trucks running on different fuels. One interviewee operating a small long-haul fleet felt it would be too difficult for them to have trucks running on multiple fuel types. This would require them to find new places to fuel the trucks and to change the routes to accommodate these stops. The interviewee felt that as a small fleet, they did not have the capacity to experiment with trucks in the way larger fleets might. An interviewee from another fleet mentioned that he did not think his drivers would be able to appropriately fuel the trucks if they were not all the same:

> *"I can't get my drivers to put the right fuel in a vehicle, gas or diesel. Having them plug a vehicle in every night may be a little touchy" (Fleet 26).*

Grid reliability was also reported as a barrier to BETs. This includes concerns about the possibility for electric grid outages which would impact the ability of BETs to charge and operate. The interviewee did not believe the electric grid was reliable enough or had enough capacity to support the additional load BETs would add. These concerns extended to the potential for Public Safety Power Shutoffs at the company's California location. With the potential for power outages lasting hours to weeks, the interviewee felt that his operations would be shut down.

Motivations or positive determinants

These fleet interviewees mentioned a total of 12 "positive determinants" or motivations for BETs. The distribution of the number of mentions of each motivation is illustrated in Figure 17.

Compliance with External Regulations was the most frequently reported motivation for BETs. For example, some interviewees mentioned the San Pedro Bay Ports Clean Air Action Plan as prompting them to investigate and acquire zero- and near-zero-emission trucks including BETs. Similar discussions were reportedly in progress at the Port of Oakland. One interviewee stated that while the forthcoming regulations have caused them to investigate BETs, they have not yet acquired one because,

> *"The Port hasn't set a deadline yet, and no matter how bad that sounds, without a regulation, we're going to continue to operate our diesel tractors" (Fleet 16).*

Interviewees are concerned that they will be "heavily impacted" by the State of California's forthcoming Advanced Clean Fleets rule, requiring them to consider the feasibility of BETs.

Internal company goals and policies pertaining to fleet sustainability and electrification were considered a motivation for BETs in some fleets. One interviewee reported their organization was motivated to set their own internal electrification goals when the State of California announced requirements for 100% of truck sales in the state to be zero emission by 3035. Five fleets in the sample mentioned having goals to transition entirely to zero emission trucks over certain time frames so they can be seen as leaders in electrification.

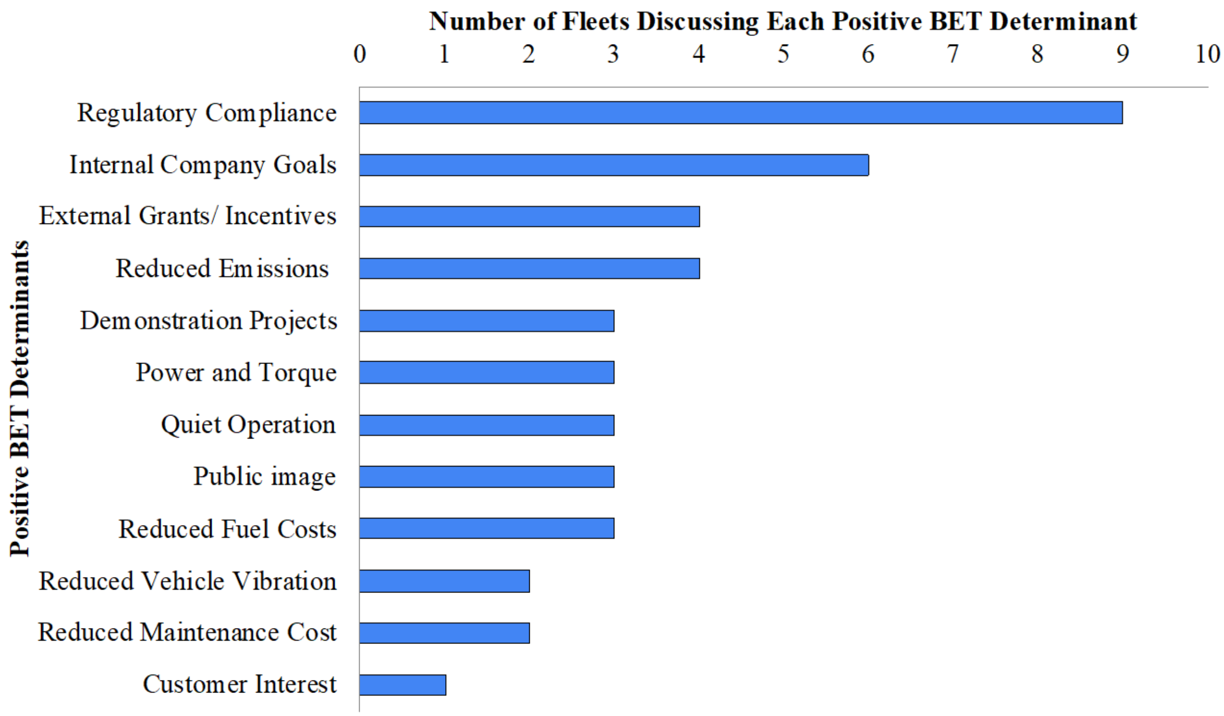
BET purchase incentives were seen as important both for fleets who have already acquired BETs and for those who plan to do so in the future. Interviewees operating trucks out of a central hub also mentioned the importance of incentives to support the installation of charging infrastructure.

Emissions reductions were seen as an inducement to acquire BETs, generally cited as a benefit to both human and environmental health. The criteria air pollutant and greenhouse gas emissions produced by diesel engines create negative consequences for truck drivers, the communities through which trucks operate, and the environment. Without these emissions, BETs are seen to reduce human health and environmental hazards. One interviewee operating out of the Port of Oakland mentioned their offices are in a disadvantaged community, so they were supportive of electrification,

> *"...for the sake of those residents"* and *"for the whole push for sustainable energy and sustainable transportation" (Fleet 17).*

Another interviewee had contracted with a consulting firm to help their fleet understand their carbon footprint and benchmark it against the industry.

Figure 17 Determinants for Battery Electric Trucks



Public grant and incentive programs were seen as inducements for BET adoption. The interviewee for fleet 14 stated,

> *"There's got to be some sort of [BET purchase] subsidy available... that's really the only way folks can get into this technology."*

Demonstration project*s* through manufacturers and leasing companies were used by three fleets in the sample to acquire BETs. This allowed these fleets to gain experience using the technology and learn how to incorporate it into their operations without requiring the upfront investment to acquire the trucks. The interviewee from Fleet 05 mentioned they were able to work with a BET manufacturer to demonstrate a few trucks under a "zero-cost proposition." After these tests, they began more serious purchase consideration.

The increased **power and torque** of an electric truck in comparison to a diesel truck were cited as benefits by a few fleets. BETs were lauded for their ability to haul heavy loads up steep grades and to increase driver satisfaction.

BETs are discussed as being significantly **quieter** than diesel and gasoline powered trucks. The interviewee from Fleet 12 stated, "*there's some positives for the battery electric, for example, number one is it's very quiet."* Notably, all three fleets reporting this benefit had experience operating BETs.

Some fleets mentioned **public image** benefits associated with electrification as distinct from meeting internal sustainability goals. One interviewee mentioned that as their company is publicly traded they were forced to adopt an attitude of "*do the right thing… if the technologies are out there, go after it, let's figure it out*." Interviewees from two companies discussed the obligations to sustainability they felt as public-facing brands. An interviewee from one such company recalled the recent push towards sustainability beginning about five years ago. They used these pressures to begin a conversation around alternative fuels with their preferred truck manufacturers. These organizations use public pressure as a motivation to create internal sustainability goals.

The decreased **fuel costs** of BETs compared to diesel and gasoline powered trucks led interviewees to discuss potential associated cost savings. The interviewee from Fleet 19 stated,

> *"Obviously we spend a lot on gas. So, we've looked a little bit into the possibility of some electric vehicles."*

Reduced vibrations of BETs compared to diesel trucks were noted by interviewees recalling conversations with drivers who had tested BETs. One interviewee stated,

> *"the driver loves that extra weight because there's no vibration… he gets a more fluid ride (Fleet 12)."*

Interviewees perceived reduced time and cost associated with **maintenance** for BETs compared to conventionally fueled trucks as a benefit given that,

> *"there's actually less on an electric truck to go wrong… and then electric motors can actually be swapped out quite fast (Fleet 02)."*

Another interviewee reported that they expect BETs to last two years longer than their diesel counterparts due to their reduced maintenance requirements.

Customer demand for the fleet to operate BETs was mentioned by one interviewee,

> *"We have a couple customers that basically came to us and asked us, would we be interested in purchasing electric vehicles so they can basically put it on their website saying they use electric vehicles" (Fleet 19).*

Despite the request, this fleet did not purchase BETs because they did not feel there were any available that met their operational needs.

Fuel Cell Electric Trucks

Barriers or negative determinants

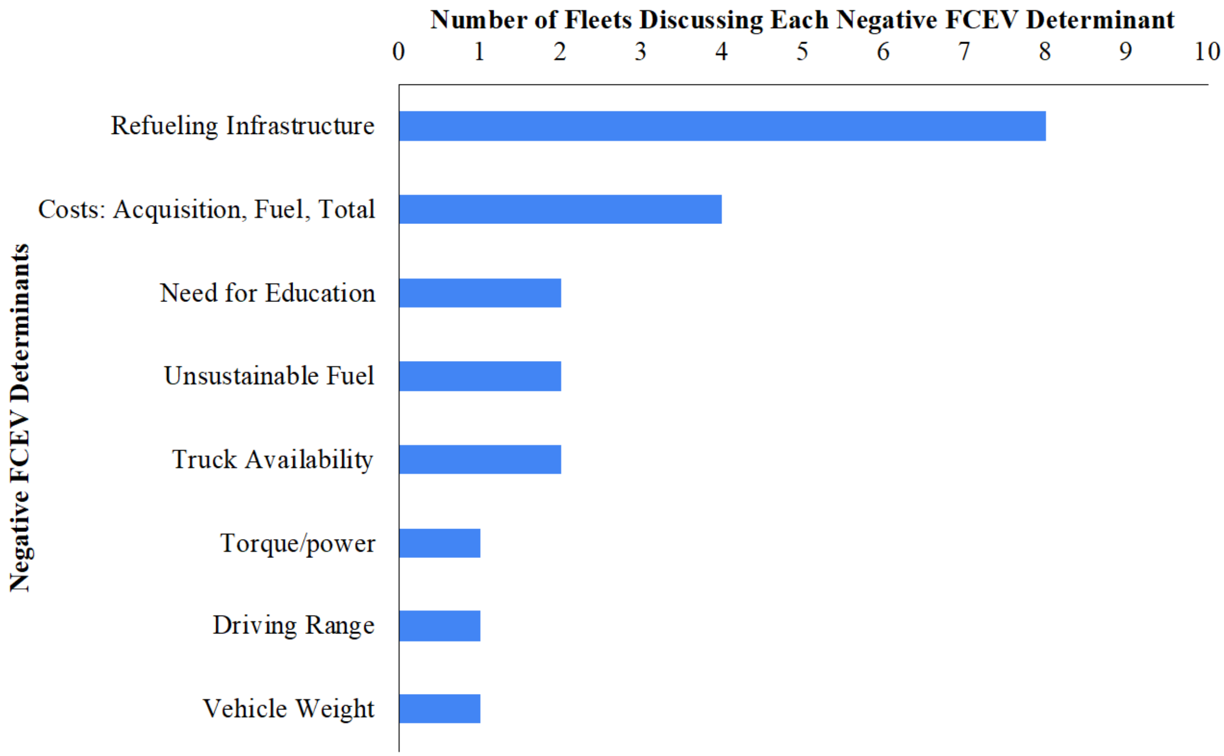
Interviewees mentioned a total of eight "negative determinants" or barriers to FCET adoption. The distribution of the number of fleets mentioning each barrier to is illustrated in Figure 18.

Lack of available **refueling infrastructure** was the barrier mentioned by the most fleets. Interviewees expressed their desire for hydrogen fueling stations to be available throughout North America and to become as prevalent as diesel fueling stations. One interviewee stated,

> *"I need to be able to get fuel without having to detour 50 miles this way or 70 miles that way because we have a limited amount of time" (Fleet 30).*

Others believed hydrogen fueling stations were in the process of being built out, but this would take a few years, and stations would only be placed along corridors used by companies purchasing large truck volumes. Despite having a fueling station approximately 10 miles from their depot, the interviewee from Fleet 14 believed fueling would be inconvenient because, "*depending on the time of day you go, it would take you 30-40 minutes to go that 10 miles*."

Figure 18 Determinants against Fuel Cell Electric Trucks



Cost was the second most mentioned barrier to the adoption of FCETs. This is a general category including upfront cost of the truck, total cost of ownership, and the cost of hydrogen. One interviewee estimated the purchase price of an FCET to be four or five times the price of a diesel truck. Another interviewee stated, *"I think it's a fuel that makes sense, but frankly, when you have to pay $17 a kilogram to get about 60 miles, don't talk to me about TCO in hydrogen fuel cell, because that ain't going to pencil out, I don't care who you are" (Fleet 14).*

Need for education and the fear FETs **lack sustainability** tied for the third and fourth most mentioned barriers. Interviewees reported they and other fleet decision-makers were not well educated about how fuel cells work and the availability of the products. The interviewee for Fleet 15 suggested that a primary reason hydrogen FCETs were not more commonly used was,

"just [the lack of] familiarity with the liquid hydrogen. When you say, 'liquid hydrogen', people tend to go right to bombs… they think the worst on liquid hydrogen."

One fleet mentioning their concern hydrogen was unsustainable believed that it had the potential to be the "*fuel of the future*" but that FCETs were not likely to play a role in the fleet until the "*well to wheel*" carbon emissions of hydrogen were reduced.

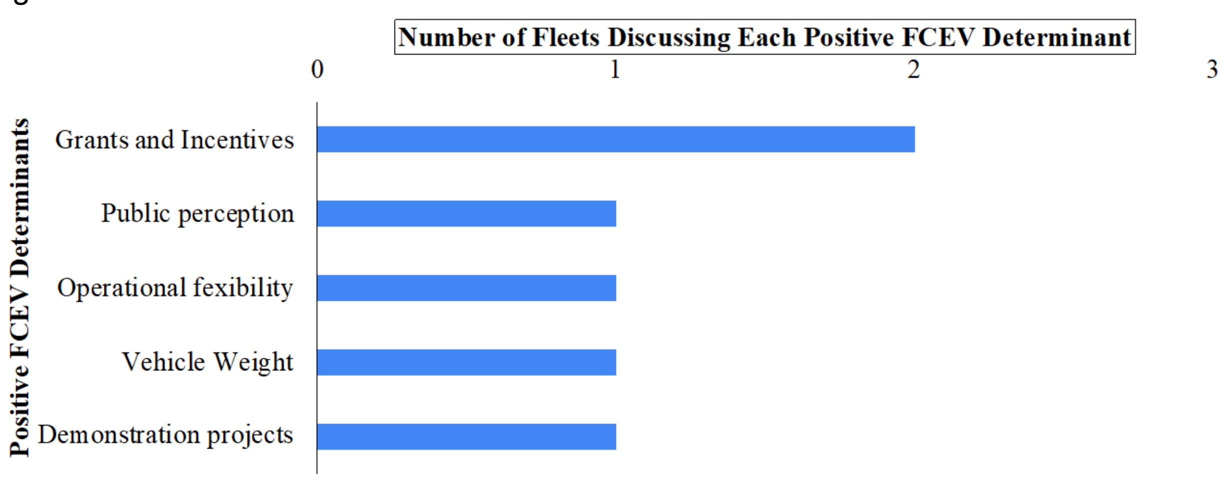
Lack of **FET availability** was seen as a primary constraint for two interviewees. One company was looking to transition their trucks to zero-emission, but could not find any hydrogen FCETs in production, so they instead acquired BETs. The remaining four barriers were each mentioned by one interviewee.

Torque and power, range, and **weight** barriers were all mentioned by a single interviewee who did not believe an FCET had enough power to carry their loads and that they could not travel 400 miles per refueling session. This would constrain the truck to local operations centered around a fueling station. The same interviewee expressed their concerns about the weight of the truck, although they did not elaborate.

Motivations or positive determinants

Interviewees mentioned a total of five "positive determinants" or motivations for FCET adoption. The distribution of the number of mentions of each motivation for fuel cell trucks is illustrated in Figure 19. These were provided by just three interviewees.

Figure 19 Determinants for Fuel Cell Electric Vehicles



Grants and incentives were mentioned by two interviewees. The interviewee from Fleet 15 had mentioned the high purchase cost of FCETs as a primary barrier. He felt that if grants were available to bring the price down it would be a "*big gain*" for helping the company purchase these trucks. Fleet 12's interviewee attributed the use of grant programs (funded through their air quality management district, the California Energy Commission, and a manufacturer) with allowing the company to install a hydrogen fueling station on their property and participate in an FCET demonstration program.

The interviewee for Fleet 12 mentioned the positive *public perception* they received from using an FCET was a "*very important*" motivation. He recalled a period when,

> *"We really could not put that [truck] into operation because it was out showing all of these city leaders and things the capacity of the truck."*

While the company moves containers within 25-30 miles of the port for an estimated 67% of the routes, the same trucks are used to serve longer routes of approximately 80 miles one-way. The interviewee felt an FCET was better able to meet their current operational schedules, which require trucks to operate over both long and short distance routes.

Vehicle Weight was identified as a benefit of FCETs compared to BETs (but without any specific reference to diesel trucks). The company had begun looking into zero emission truck purchasing, and found that BETs,

> *"…don't have the payload [needed] because of the weight of the batteries. Hydrogen fuel cell gets you around that problem, you can have a very good payload because the fuel cell and the necessary batteries for that are way less" (Fleet 18).*

Demonstration Projects were cited by Fleet 15 as important to allowing their company to use FCETs. The interviewee was in negotiations with multiple manufacturers to demonstrate these trucks, which would allow them to see how they fit in with the company's operations. The interviewee was hopeful that demonstrations would allow FCETs to, "*take off and everybody [will want to] to run hydrogen in trucks*."

Natural Gas trucks

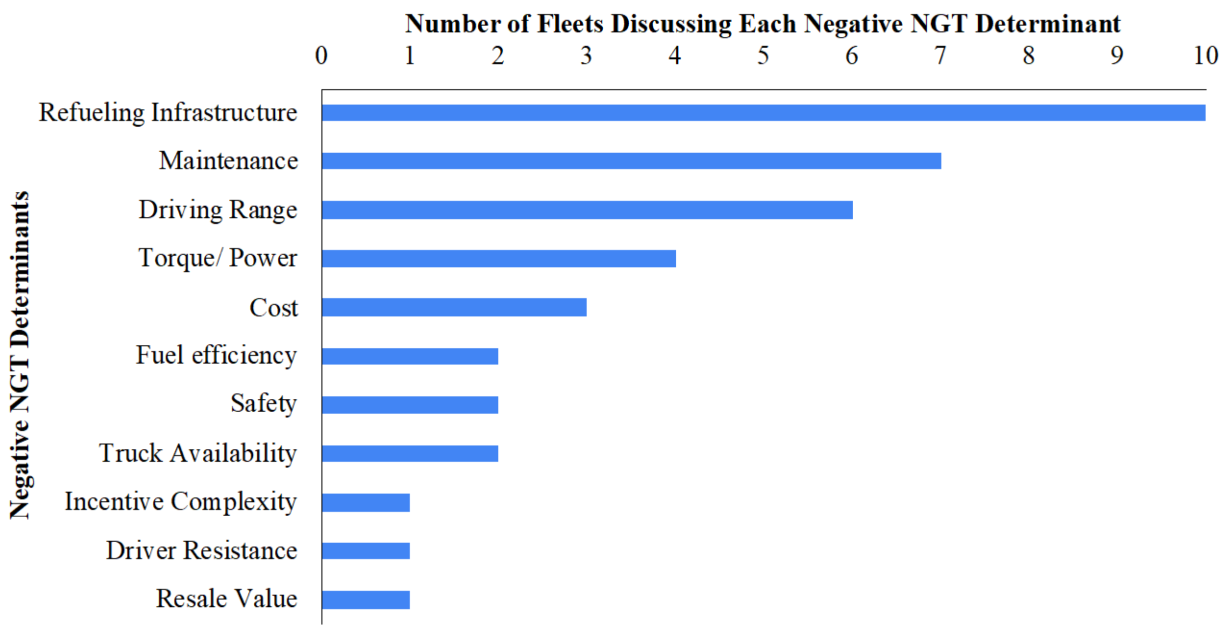
Barriers or negative determinants

Interviewees mentioned a total of 11 "negative determinants" or barriers to natural gas truck (NGT, including CNG and LNG) adoption. The distribution of the number of mentions of each barrier to natural gas trucks is illustrated in Figure 20.

Lack of **refueling infrastructure** was the most mentioned barrier to NGTs. Some fleets operating trucks country-wide report only being able to operate NGTs in states that have supportive fueling infrastructure, such as California and Texas. The interviewee for Fleet 12 mentioned their Southern California operations were able to run 90% CNG trucks. However, he went on, *"The East Coast does not have as much CNG infrastructure as the West Coast. So, on the East Coast we'll look at clean diesel because I need to have fueling infrastructure along the routes that we're delivering to. So that's the biggest determining factor."*

Without ubiquitous natural gas fueling stations, interviewees feel that they would have to search for fueling stations and modify routes to accommodate them which, "*gets complicated quickly*" (Fleet 02). Interviewees felt that some local regions had enough infrastructure, but their operations required more of broader multi-state infrastructure system. Fleet 21's interviewee mentioned their company tried to overcome the lack of natural gas fueling infrastructure in their area by contracting with another company to have a fueling truck come to their depot every day to fuel their trucks. This process was cumbersome, but the interviewee continued to use it until they were able to install their own CNG station at the facility.

Figure 20 Determinants against Natural Gas Vehicles



Maintenance concerns was the second most mentioned barrier to NGTs. Interviewees in fleets with experience operating NGTs reported experiencing more downtime for NGTs in comparison to diesel trucks. One interviewee reported selling their NGT trucks after a few years because they were down for maintenance too often. Another fleet who previously leased NGTs said leasing companies were no longer willing to offer leases on NGTs because the maintenance costs were too high. Maintenance concerns extended to the inability to find qualified technicians and warranty centers to work on NGTs as well as a lack of parts supply. The interviewee for Fleet 18 who has persevered with NGTs said they had internalized the cost of maintaining them:

"In the end, we found it was better off just to get our folks trained and maintain them ourselves, but there's still some parts issues."

Limited **driving range** was the third most mentioned barrier. Interviewees did not believe NGTs would allow them to complete their daily routes. One fleet mentioned their need to identify use cases where, "*the service territory fits the range limitations*" (Fleet 05).

Concerns over the **torque and power** of NGTs was the fourth most reported barrier. When asked their thoughts on NGTs, the interviewee from Fleet 24 stated,

> *"they suck, we don't like them… they just don't have the horsepower… once they go up hills it's like, 'Oh my god, I hate life.'"*

Similarly, the interviewee from Fleet 04 has,

> *"a little bit of concern about pulling power because [the NGT] doesn't have the same diesel equivalent energy as a diesel truck."*

The fifth most mentioned barrier to NGT acquisition was **cost**, including higher purchase cost and total cost of ownership, and difficulty securing financing. The interviewee for Fleet 21 mentioned being able to deploy NGTs in applications with high fuel use because the lower fuel costs helped bring down the total cost of ownership on the truck. Conversely, the interviewee was not able to purchase NGTs for their lower-mileage applications because they did not use enough fuel to offset the higher purchase cost. Fleet 13's interviewee noted that even when factoring in incentives, the purchase price of NGTs was significantly higher than diesel trucks. This led leasing companies to reportedly offer leases which were approximately 30% higher than the price of a diesel truck. The interviewee further noted that they were unable to finance a NGT purchase either because they, "*have yet to find a bank that wants to continue to invest in CNG for the commercial fleet.*"

Concerns over poor **fuel efficiency, safety,** and **availability** of NGTs all received mentions from a couple fleets each. Lower **fuel efficiency** in comparison to diesel trucks was mentioned by two interviewees who had experience operating NGTs. One of these interviewees reportedly had discontinued the use of NGTs partially due to their poor fuel economy.

Safety concerns were mentioned regarding LNG trucks only. Fleet 12's interviewee reported they were no longer purchasing LNG trucks because,

> *"it's not safe for a driver to fuel the trucks. It has a blowback that is negative. I think, 280° or wherever it is, and it can freeze body parts and we had two guys that got burnt…so we don't even deal with LNG for those purposes anymore."*

Fleet 12 still operates LNG trucks, but now requires the fuel provider to have an on-site attendant who fuels the trucks for the company. Similar concerns led Fleet 18 to designate certain employees to do the fueling for the company. These employees are required to undergo special training and wear personal protective equipment.

Lack of NGT model **availability** across all truck classes was mentioned by interviewees from Fleets 18 and 35. The interviewee for Fleet 18 mentioned the market for LNG trucks was extremely limited, causing them to lean more towards CNG trucks. While they used to have a mix of CNG and LNG trucks, the company, "*can't get this type of truck in LNG anymore, it's only available in the CNG*" so they are transitioning all their LNG trucks to CNG.

The remaining three barriers were each mentioned by one interviewee each. **Incentive complexity** was described by the interviewee from Fleet 13. The company had previously acquired an NGT with the use of a government subsidy, but felt that financial support ended after the initial purchase:

> *"Right now, in California, I can't replace a CNG [truck] and get an incentive on the purchase price for [another] CNG unless I'm replacing a diesel truck. In other words, I have a CNG that I need to replace, there's no incentive for me to replace it with another CNG, so I'm kind of stuck."*

Driver resistance to CNG trucks was mentioned by the interviewee from Fleet 18, who stated that reliability problems with CNG trucks created problems with driver retention. They noted, "*the drivers don't like those, and they've let us know that*." The interviewee continues to purchase CNG trucks because, "*it's alt fuel and it will do the job*," but was concerned about the impacts this had on diver retention.

The lower **resale value** of NGTs was mentioned by the interviewee from Fleet 22, who believed that there was less of a market for used NGTs. When trying to resell NGTs that had been used in their fleet, the company felt they needed to sell the trucks to fleets in Mexico because NGTs have a better resale value there.

Motivations or positive determinants

Interviewees mentioned a total of five "positive determinants" or motivations for natural gas truck adoption. The distribution of the number of mentions of each motivation for natural gas trucks is illustrated in Figure 21.

The availability of **grant and incentive** programs was tied as the most mentioned motivation for NGT acquisition. Interviewees mentioned receiving grants through the California Energy Commission, Air Quality Management Districts, Volkswagen Mitigation Fund, California Air Resources Board, and the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP). Fleet 21's interviewee stated that while the $15,000 incentive they received for a NGT was not enough to offset the $40,000 purchase price increase,

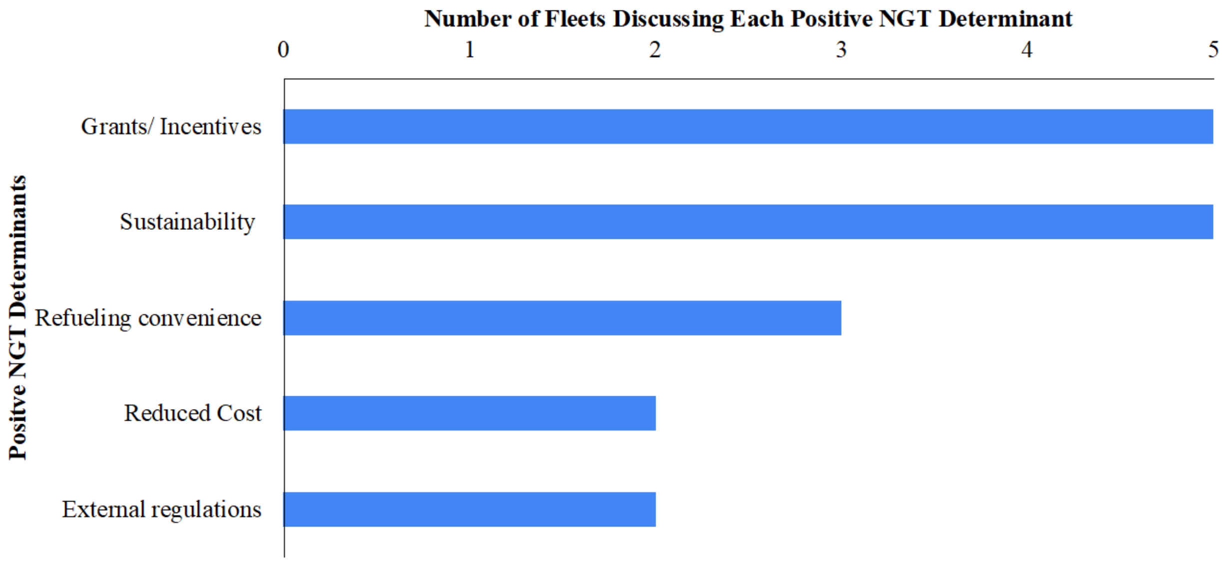
> *"it was enough for us to make the decision that this is the right thing to do, we want to burn alternative fuels. Even though we're not going to get our money back, we've got an incentive to augment that."*

Fleet 14 also received incentives for their NGT purchases. Their interviewee stated the importance of the program providing incentives "*on the front end"* because this,

> *"knocked off the purchase price, which is much more attractive and easier to manage than to send it in for rebates and track that."*

Fleet 12's experience participating in demonstration projects funded through grants from the California Energy Commission and the Air Quality Management District led them to eventually purchase 41 CNG trucks.

Figure 21 Determinants favoring Natural Gas Vehicles



Sustainability was tied for the second most mentioned motivation for NGTs. Fleet 12 has sustainability goals in place requiring them to phase out diesel trucks in favor of low- and zero-emission trucks. This led the interviewee to transition 90% of the company's Southern California trucks to CNG with the remaining diesel trucks expected to be phased out by the end of 2022. Fleet 25's sustainability goals require the interviewee to purchase only alternative fuel vehicles, including NGTs. If the interviewee feels that a diesel truck is needed for a certain application, they must have the company's environmental team sign off on the purchase. These interviewees had an overall sentiment that NGTs were a more sustainable technology than diesel but would overall be a transition technology on their paths to zero-emission trucks.

Improved **refueling convenience** of NGTs in comparison to BETs was the third most mentioned motivation and led some interviewees to prefer NGTs over BETs. All three companies that mentioned refueling convenience as a benefit operated in regions where public CNG fueling stations were available. Additionally, one was able to install CNG fueling at their facility.

Reduced costs and **external regulations** were all mentioned by two interviewees. Lower fuel costs helped Fleets 16 and 21's CNG trucks achieve a lower total cost of ownership than diesel trucks running in the same application.

External regulations were mentioned as a primary motivation for NGT acquisitions in Fleets 12 and 16. Both fleets conduct drayage services at the Ports of Los Angeles and Long Beach and discuss the impact of the Ports' Clean Air Action Plan (CAAP) on their purchasing decisions. Fleet 12's interviewee reported beginning to purchase CNG trucks in 2018 and 2019 because of the CAAP's requirements. The interviewee from Fleet 12 reported similar motivations for CNG truck purchases, stating they purchased because of

> *"CAAP 2.0. So, the ports in 2025 are going to charge my client or me a fee per container like they did in 2010…and in order for us to be competitive again, I*

can't charge that $20 to the client. Especially because we moved 10,000 containers last year…it's going to be an extra $200,000 to every client."

Implications of Alternative Fuel Results for CARB's regulatory programs

The statements made by decision makers in fleets operating MDHD trucks in California suggest several implications for CARB's regulatory programs.

- While a few fleets have developed the expertise and knowledge to take advantage of grants and to participate in demonstration programs, several fleets report that applying for and participating in grant and demonstration programs is too complex.
- While fleets do use social media and do interact with other fleets to gather information about various relevant issues, fleets appear to make decisions based primarily on their own experience and less so on the experience of other fleets. To broaden knowledge of new technologies, CARB could promote broad sharing of information across all fleets especially the experience of fleets operating new technology trucks. For example, the inherent advantages of electric trucks are not widely known, but widely promoting the experience of fleets using electric trucks could lower this barrier to adoption.
- Leasing trucks may be a strategy to try newer technologies such as zero emission trucks with lower barriers than purchasing those trucks. Large leasing companies may be better able to internalize the uncertainty in maintenance costs and resale value than smaller fleets. One possible near-term strategy to assist leasing companies with these uncertainties might be to include an additional voucher modifier amount for vehicles purchased and leased to fleets that are not presently subject to the Advanced Clean Fleets regulation.

SUMMARY AND CONCLUSIONS

This study solicited information directly from decision-makers in private businesses operating MDHD trucks in California as well as MDHD truck manufacturers, auction houses, and consultants providing other services to such businesses. These decision makers were asked to describe why they acquire and retire the trucks in their fleet, what trucks they acquire, how they acquire them, what trucks they retire, and why they retire them. The purpose is to build an understanding of the forces acting on the total on-road fleet of MDHD trucks. We report what fleet decision makers told us; we do not parse their statements for accuracy. If a reader thinks a fleet decision-maker is operating under a misunderstanding, then one thing we learn is such misunderstandings are part of what determines why fleets acquire and retire their trucks.

The first task, a review of prior literature, provided an essential conclusion: very little prior information exists on this topic and much of what does exist was produced by researchers assembled to conduct this study. Consultation amongst team members foreshadowed what is perhaps the overarching conclusion of this study: fleet decision making affecting truck turnover is context-dependent and idiosyncratic. There is tremendous variability across all fleets, even within common groupings e.g., fleets grouped by size (number of trucks), truck types (classes and configurations), truck use cases, and more.

The second task was to solicit information from decision makers. Participants from fleets completed a pre-interview questionnaire on-line and were then scheduled for a one-hour interview, also conducted on-line. Participants from manufacturers, consultants, advisers, and used truck resellers were interviewed but did not complete a pre-interview questionnaire. The questionnaire and interview guides were prepared based on the research objectives, results of the literature review, and principles of qualitative research design. In particular, the interviews were conducted in a semi-structured fashion: there is a pre-determined list of topics to cover, but the interview is conducted as a conversation allowing the interviewees to answer at length in their own words and shift the conversation to new topics. A stratified sampling framework was used to assure coverage of a variety of fleets by size, truck GVWR class, use cases, and organization type. By design most participating organizations were fleets; a small number of interviews with truck manufacturers, consultants to the freight industry, and leasing companies were conducted to provide additional perspectives on truck acquisition and retirement.

The final part of the interview guide included questions about alternative fuel trucks. This topic was included for two reasons. First, the topic is inherently of interest as California, the European Union, and other governing bodies will be requiring fleets operating MDHD trucks to consider, acquire, and use alternative fuel trucks. Second, the literature review and preliminary discussions indicated that alternative fuel trucks might represent a disruption of “ordinary” or “routine” truck turnover decisions. Thus, asking fleets to talk about alternative fuels is a way to get fleet decision makers to comment on how it is they already make truck turnover decisions.

The third and final task was to analyze the interviews and synthesize across them: what did each interview say about decision-making and how does it compare to other interviews? This was done through coding interviews for determinants of fleet turnover and the creation of a typology of decision making as it relates to truck turnover. The typology organizes which specific fleets are compared in case studies of several of the decision-making types. Generalizations across several fleets are based on both the decision-making case studies and a broader reading of all the summaries. Finally, a subset of fleets is used to advance the analysis of determinants specifically to the case of alternative fuel trucks.

Summary results are presented across the main types of results: determinants, typology and case studies, generalizations, and alternative fuels. At the level of determinants, we report results from the perspective of individual fleets. At the levels of decision-making types, similar results can often be restated as generalizations across fleets and decision making types.

Determinants

Determinants of fleet turnover are the metrics, heuristics, judgements, histories, hunches, relationships, practices, and decision-making processes that cause fleets to acquire and retire trucks. As the preceding list of types of determinants implies, determinants vary widely. Similar determinants are expressed by some operationally similar fleets (e.g., size, truck class, application), yet many other operationally similar fleets differ as to their determinants of truck turnover.

- T**otal cost of ownership (TCO**), though a standard approach in academic, policy, and regulatory analysis, is not commonly used by fleets to determine truck turnover.
    - Fleets are more likely to report their truck acquisitions and retirements are based on established practices, including this non-exhaustive list:
        - Experience with specific makes of trucks and established dealer or manufacturer relations, and
        - Heuristics related to truck age, truck miles, maintenance incidence or cost, and resale value.
        - A comprehensive cost calculation such as a TCO may itself be turned into a heuristic. That is, the fleet doesn't repeat such a calculation over time, rather establishes the course of action recommended by a single instance of cost modeling as a routine practice.
- **Fuel economy** is not commonly discussed as a determinant of truck acquisition despite fuel expenditures typically being the first or second largest fleet cost especially for fleets operating heavy-duty trucks in long-haul service.
    - When fuel economy is discussed, how it is discussed varies. It may be expressly rejected as an acquisition determinant. It may be one of many different determinants to be balanced, perhaps even in a TCO calculation. Or, it may approach the status of the sole metric to be optimized.
- **Maintenance** is commonly used as a determinant in truck acquisition and retirement.
    - An accounting of financial maintenance costs is only one of many ways maintenance acts on truck acquisition and retirement decisions.
    - As it affects truck acquisition, a manufacturer's reputation for "durability" and "reliability" as well as the fleet's expectations of future maintenance costs may be the metric of "maintenance."
        - History of past maintenance cost differences between two (or more) trucks can replace ongoing evaluation. If a fleet experiences lower maintenance costs and/or better reliability with truck brand A compared to truck brand B, that experience becomes a heuristic: "Buy truck brand A." This

        "loyalty" heuristic becomes the decision rule, replacing a past practice of comparing maintenance costs.
        - In addition to experience, relationships with fleets and truck manufacturers, sales dealerships, or leasing companies may create these loyalty heuristics for maintenance and the related concepts of durability and reliability.
    - In truck retirement, we observe the same variety ranging from a simple heuristic to ongoing tracking of maintenance costs. What these all have in common is judging when the cost of maintaining a truck (as well as the costs associated with unexpected repairs—both the direct repair costs and potential loss of revenue) outweighs the expense of acquiring a replacement truck (whether the replacement is required as a new or used truck).
        - A measure of truck age—typically total miles, but possibly years of service or engine hours—may be used as a heuristic in place of actual costs. These heuristics take the form of thresholds that trigger either truck retirement or review for retirement.

- **Driver satisfactio**n has two effects on truck turnover. Taken together, the effect of driver satisfaction on turnover seems to cause fleets to turnover more quickly while retaining trucks that are not too dissimilar from those with which drivers are already familiar.
    - First, fleets report turning over trucks more quickly to retain drivers. All else being equal, this would lead to a "younger" on-road fleet of trucks.
        - Contrary to this, fleets may specify features of new trucks despite the expressed views of their drivers. Features such as cameras with a view inside the truck cab are one example cited as invoking driver resistance.
    - Second, driver satisfaction is expressed as a generally conservative force, resisting change in truck design and performance. Drivers are described as getting used to the way "their" trucks operate; in short, drivers want newer trucks that are like the trucks they already drive.

- **Leasing** accounts for a smaller share of truck acquisitions than purchases, but fleets and leasing companies report leasing's share is presently increasing.
    - Leasing shifts control of fleet truck turnover away from the fleet and toward the leasing company.
        - Lease periods start to define when trucks are replaced rather than whatever determinants or processes fleets used prior to leasing.
        - Even if the fleet can negotiate the lease period, this time-heuristic becomes a new factor in that fleet's truck turnover.
        - Reports of this effect emphasize truck turnover is quicker for leased than for owned trucks.
    - Leasing shifts costs from fleet to leasing company on the one hand but hides those costs in the lease payment on the other. The costs shifted to the leasing company include costs of truck maintenance and reporting costs to regulatory agencies including costs associated with emissions testing and certification. It may also reduce back-office costs as the personnel to manage maintenance and reporting as

the fleet may no longer require those personnel. These costs shifts may not result in any actual costs reductions.

Determinants may be linked together into sequences of cause and effect. The case of fleet 8 is illustrative. The truck manufacturer from which fleet 8 purchased all their trucks stopped making a specific truck—a short wheelbase class 8 tractor. In response, fleet 8 who had only *purchased* trucks (short- and standard-wheelbase) from that one manufacturer started to *lease* replacements for the short wheelbase truck from another manufacturer. Once fleet 8 started leasing those trucks, they also started to lease standard wheelbase trucks from the second manufacturer. The retirement criteria for the leased trucks are linked to the lease terms. Thus, different retirement rules were being used for purchased vs. leased trucks. Specifically, the leased trucks were turned over faster than all trucks were turned over when the fleet owned all their trucks. Once they started retiring leased trucks sooner, fleet 8 noticed how much maintenance costs increased in older trucks. Now, every truck in their fleet, owned and leased, is turned over three to four years sooner than it would have been under fleet 8's old, i.e., pre-leasing, practices.

Decision-Making Typology and Case Studies

The three dimensions of the typology are decision making structure as it pertains to truck turnover decisions, adaptation, and decision process complexity. All three of these are grounded in the data collected for this project. The case studies illustrate the resulting types.

Structure

Structure describes the organization of decision-making pertaining to truck acquisition and retirement within a single fleet. The basic distinction is whether a single person makes these decisions by themselves (sole) or with other people in the organization (group). Group structure is further divided based on the relationships between the group members. Members of egalitarian groups share a similar level of responsibility. Hierarchical groups consist of people who have different roles and different levels of responsibility or authority. Siloed groups consist of people with the highest level of authority over only part of the decision.

Hierarchies are observed in fleets ranging in size from small to large. The hierarchy may be as simple as two levels. This is true for fleet 39 (Case study 5) in which the hierarchy consists of the interviewee—the fleet's equipment manager—and the company president. Their arrangement is hierarchical because in any difference of opinion regarding truck acquisition or retirement the equipment manager will *"acquiesce and change to whatever [the boss] wants."*

Hierarchies may also have more levels and greater variety of groups or departments in the hierarchy. For example, the interviewee for Fleet 37 works as the Safety Director and Fleet Manager. He oversees the decisions on which trucks to purchase, however he needs the Maintenance Manager to sign off on these decisions. However, our interviewee's scope for which trucks to buy is proscribed by the company owner who has directed the interviewee to purchase a specific make and model of class 8 truck. As a result, those trucks make up about 90% of their fleet. The interviewee notes, *"it's his decision to prefer that manufacturer and our duty to keep that going."*

If the company is a wholly owned subsidiary of a parent company, the parent company may impose policies that have the effect of being a higher-level in a hierarchy. Such is the case for fleet 85: its parent company imposes a “buy American” policy on medium-duty trucks.

Egalitarian decision making is characterized by equal power among multiple decision makers. It is observed in fleets ranging in size from small to large and among groups of people as small and close-knit as two family members (Fleet 49, Case study 1) and as large as teams from multiple departments spread across the nation (Fleet 15, Case study 2). That interviewee described their truck acquisition decisions as coming from a team of 14 people working across fleet operations, asset management, engineering, and maintenance, all exercising similar influence over decisions.

Siloed decision-making occurs when different people have complete control over different aspects of the decisions leading to truck acquisition or retirement. It is not common among the fleets in this study; only one case study (Case study 7, Fleets 1 and 12) describes it though the two examples are very different suggesting the possibility siloed decision-making can exist across a wide variety of fleets. Fleet 1 is a family-owned, mid-size long-haul carrier serving the western US. The decision-making silos have to do with steps in the acquisition process—deciding which trucks to acquire and whether to purchase or lease. The interviewee has sole responsibility for what trucks to acquire; the other company principal has sole control over whether those trucks will be purchased or leased.

In contrast, Fleet 12 is a complex organization with complex trucking operations. The decision-making silos are between regional offices within Fleet 12 and between Fleet 12 and its contractors. Fleet 12 is hierarchically organized as one central company overseeing six regional operations. Fleet 12 owns about 200 trucks but also contracts with hundreds of other smaller freight carriers. Fleet 12 exerts no control over the trucks of those contractors. While Fleet 12’s central company promulgates a general truck specification and a preference for purchasing trucks, these specifications, each regional operation makes its own decisions about truck manufacturer to fill that specification and whether to buy or lease their trucks.

Sole decision-making is the only decision-making structure in which the authority to make all decisions related to truck acquisition and retirement is vested in a single person. While a solitary owner-operator is one model of the sole decision maker (Case study 8), we observe sole decision makers in medium and large fleets (Case study 10). Neither should sole decision-making be confounded with complexity of decision processes; we observe both simple (Case studies 8 and 9) and complex (Case study 10) decision processes by sole decision makers.

Adaptation

Adaptation describes whether the fleet’s truck acquisition or retirement decisions tend to lead (proactive) or follow (reactive) internal actions or policies and external factors. The most common example in the data are fleet responses to emissions regulations. A proactive fleet enacts acquisition or retirement decisions based on planning done in advance of known new regulations. A reactive fleet lets the new regulations come into effect before modifying truck acquisitions or retirements.

Holding structure and complexity constant (hierarchical, simple), Case studies 3 and 4 allow a comparison of reactive and proactive decision-making. Fleets 42 and 56 (Case study 3) both stay ahead of regulatory emissions requirements in California, shifting to leasing so they have newer trucks and shifting older trucks to operations outside California. There may be limits to their proactive stance toward emissions requirements: Fleet 56's rigorous own truck inspection program is a cost-saving measure implemented in part to assure their trucks will pass US DOT truck inspections. The interviewee explained something as simple as a broken headlight flagged by inspectors could take a truck out of commission for days while waiting for parts (COVID 19 effects on supply chains increased repair times). Fleet 56 may have to rent a truck during that time, resulting in a significant cost. External determinants such as these US DOT truck inspections, CARB emissions regulations, and federally mandated accounting changes have been dealt with in a proactive manner—changes were made to operations and truck turnover to forestall possible future costs.

Still holding structure constant (hierarchical) but switching to hold complexity constant at the level of complex, Case studies 5 (proactive) and 6 (reactive) allow another comparison of adaptation. The existence of ESG policies within both fleets in Case study 5 (Fleets 5 and 39) is the primary indicator of proactive decision-making. Both are aware of impending emissions regulations. Both maintain a broad network of industry contacts, searching for information and opportunities to test within their fleets new truck technologies that may keep them compliant with new requirements. Both operate large, bureaucratically complex organizations which provide the resources and requirements for complex and proactive decision making. This results in truck turnover decisions that are made based on complex algorithms that synthesize data from all three types of determinants—internal, external, and linking.

Neither of the fleets in Case study 6 (Fleets 37 and 58) is as large as the two in Case study 5, both Fleet 37 and 38 have three-tiered hierarchies making truck turnover decisions. They are classified as reactive given their reluctance to invest time and money into researching new technologies or to proactively test them in their fleet. The interviewee for Fleet 37 said they were beginning to investigate alternative fuels but would only really consider trucks offered by one manufacturer. The interviewee further stated that they were not considering any specific fuel types, just looking at *"whatever is available."* If the expected cost per mile (CPM) of an alternative fuel truck was higher than their current CPM, the owner would not likely consider it,

> *"He's not going to spend money just to change the fuels. He wants to see that it is equal or better in CPM."*

Fleet 58 was further along in their consideration of alternative fuel trucks, having signed a contract to purchase an electric van. This vehicle was purchased for the company's California operations, "*because [the company] gets a $60,000 credit."*

Both fleets have sophisticated algorithms to combine many internal determinants of fleet turnover. However, in the case of Fleet 37 this calculation has been used to create stasis in truck acquisition; once a specific make-model of truck was determined to have the best CPM (ten years ago) that output became a new decision rule: buy this make-model truck. In this sense, its truck acquisition decisions reproduce a status quo. Both these fleets are waiting for external forces to motivate them to invest in changing their fleet.

Complexity

Complexity is a function of how many determinants go into truck acquisition and retirement decisions, the importance of each determinant to decisions, the details of data collection for the determinants, and the complexity of any algorithm used to synthesize determinants. To make the measure practical for the purposes of creating a typology, complexity is reduced to a binary distinction between simple and complex. Simpler decision making is based on one or a few determinants and use of heuristics; more complex decision making uses more determinants, more sophisticated data collection and tracking, and frameworks for synthesizing the effects of determinants. As extreme examples, the use of a total mile heuristic based on periodic checks of the trucks' odometers is simple while a total cost of ownership calculation based on real-time data from telematics systems in every truck is complex.

The comparison of simple and complex decision-making is clearly made by holding structure constant at sole decision-maker and adaptation constant at proactive while allowing complexity to take the values of simple (Case study 8) and complex (Case study 10). Both fleets in Case study 8 (27 and 31) are owner-operators of a single truck providing long-haul service. While both keep extensive records on their trucks, their imagined next truck purchase comes down to a couple decision rules (Fleet 27) and even fewer rules as the relatively new owner-operator of Fleet 31 faces choices that are sharply proscribed by his leasing company. As the owner-operator of Fleet 27 looks forward to another truck, he expresses a clear and simple hierarchy of determinants. First is fuel economy. This leads him to limit potential brands to only two. Second, he believes one of these brands has a better reputation for "durability, reliability, and uptime." Thus, without conducting a single calculation or cross-cutting analysis and without actively shopping for a new truck, he has decided what truck he'll buy next.

As a young, new owner-operator acquiring his first truck, Fleet 31 was more constrained than fleet 27—there were no determinants that were under his control so he acquired what he could. As a new owner-operator with limited credit history he was unable to finance the purchase of a truck and had to select a truck leasing company who focused less on credit scores. The lessor offered only two trucks and while he preferred one, he leased the other as it was more readily available and was the same as the truck he had learned to drive. His imagination of a future truck acquisition comes down to personal history and brand reputation. Further, his calculations show him how important fuel economy is to his fuel costs, so fuel economy will also be a determinant. However, he does not combine these three into a single metric to be compared across a variety of new trucks. Rather, he describes this future acquisition as short sequence of if-then propositions. If his current truck continues to perform well, e.g., maintenance costs remain low, and his preferred brand is not readily available, he will exercise his option at the end of the lease to buy his truck. If his preferred brand is available, he will lease one and then purchase it at the end of its lease.

Switching to Case study 10 allows a look at complex decision making by sole decision-makers in Fleets 16 and 33. Both Fleets 16 and 33 account for many determinants involving detailed data collection and analysis. Fleet 16 keeps detailed records of maintenance and operating costs which are used to identify trucks with higher operating costs so they can be removed from the fleet. The interviewee mentioned they still have 2010 model year trucks running while 2015 model year trucks are being retired because they have higher operating costs. Fleet 33 utilizes an automatic fuel tracking system and has a maintenance manager who tracks the maintenance costs of trucks.

The interviewee for Fleet 33 does not restrict his truck purchases to any specific brands but developed a standard truck specification he uses to gather quotes. They are evaluated based on purchase price, fuel economy, safety, resale value, and maintenance costs. While Fleet 33 has purchased other brands in the past, it currently only purchases one brand of truck because drivers prefer them, and their in-house maintenance is certified to do warranty work on them.

Tying the Decision-Making Typology to the Research Questions

The typology dimensions are linked to the overall research question stated at the top of this Summary and Conclusions section. Structure is who makes the decisions. Adaptation is whether the fleet proactively plans for future contingencies or reacts to matters as they arise. Complexity refers to how many determinants are used to make truck acquisition and retirement decisions and the complexity of the process in which those determinants are evaluated. Structure and Complexity speak directly to the question of how fleets decide. Adaptation is a general stance each organization seems to take toward managing their fleet.

The initial purpose of the typology was to provide a simplifying view of how and why fleets acquire and retire trucks. To a degree, it succeeds in this. The typology distinguishes fleets and their truck acquisition and retirement determinants in ways that operational characteristics do not. For most statements about the determinants, it is possible to find fleets of any operational distinction—size of fleet, size and type of trucks, use cases, geographic scale, penchant for acquiring new or used trucks by purchase or lease, etc.—across the variation in determinants.

However, despite the fact the typology is the most abstract view of the data produced by this study, despite the fact the typology succeeds to some extent in classifying fleets into “types” such that fleets of a type are more like each other than fleets of another type, the case studies still reveal the central, essential finding of this research: fleets are different from each other in ways that resist easy categorization. The turnover of the on-road fleet of trucks is the sum of actions taken by nearly unique actors, either adapting to novel circumstances almost every time they acquire or retire a truck or failing to adapt by repeating past behaviors.

Generalizations

That said, we can state some generalizations, i.e., findings widely applicable to fleets and even the entire freight sector. Some of these have been discussed in relation to specific fleets in the summary of determinants section; reprising them here emphasizes their broader implications for the turnover of the entire on-road fleet of medium- and heavy-duty trucks.

Discussion of total-cost-of-ownership (TCO)

Many researchers and regulatory agencies use TCO calculations to model fleet decision-making. In contrast, most of the fleets interviewed for this research did not mention such analyses in describing their decision-making process. When pressed on this point by interviewers, many fleets responded explicitly stated a TCO calculation is either not a significant determinant in their truck acquisition and retirement decisions or not a determinant at all.

The exceptions are all the very large fleets we interviewed, including leasing companies, who do use TCO analysis. Those fleets have many trucks in many applications often from multiple manufacturers. Unlike small or many medium size fleets, large fleets have the specialized personnel and data systems to support complex modeling. A few smaller fleets, even owner-operators of a single truck, also consider TCO to be an important determinant in decision making. However, the generalization stands: the number of our interviewees who do not use TCO is far larger than the number who do.

Increased use of leasing companies

More of our interviewees purchase trucks than lease even allowing for those fleets who both purchase and lease trucks. However, the share of leasing is reported by fleets and leasing companies to have increased over the past few years and there seems to be a general expectation leasing's share will continue to increase. The reasons for this include these:

- Limited cash flow in fleets. Some fleets have limited funds and cannot afford to purchase new trucks. Even in larger fleets, transient financial or economic conditions may limit their cash flow, prompting them to lease when under "normal" conditions the fleet purchases trucks.
- Shift the cost of back-office expenses, maintenance, and other services required to support a fleet to the leasing company.
  - Leasing eliminates the uncertainty of truck maintenance and repair costs.
  - The determinants for retiring truck may be simplified to nothing more than "turn the truck over when its lease period ends."
  - Lease terms can include varying options such as rental truck inclusions, the ability to fully specify the truck, and full service versus lesser options.
  - As truck technology is becoming more complex, so too is truck maintenance. Over time, emissions regulations have required additional truck components that increase maintenance. Some fleets prefer to leave all maintenance to leasing companies. As complexity continues to increase, the pressure to move to leasing is also likely to increase driving more fleets from purchasing to leasing.

Variation in the importance of fuel economy

Fuel and labor costs are often the two largest truck costs for fleets. Since higher fuel economy reduces fuel costs, one might expect fuel economy would be an important determinant in all fleets. However, interviewees' reports of the importance of fuel economy varied widely. Some fleets explicitly stated that they do not consider fuel economy in any decision making. A few of these went so far as to claim they could not consider fuel economy because they believe such data is not published for heavy-duty vehicles. Many fleets reported the variation in fuel economy between trucks from different manufacturers is inconsequential. Rather, they believe driving conditions, especially speed, contribute more to fuel use variation. Other fleets mentioned fuel economy as a determinant but did not seem to stress its importance giving other determinants significantly more weight. Some fleets, especially large ones, did track detailed data on fuel economy, and used it in their TCO analyses.

Brand loyalty

Several fleets stated brand loyalty is a major determinant in their truck acquisition decisions: when these fleets need to acquire a new truck, they acquire one from the same manufacturer. Loyalty is product of experience. Examples of the rationales for brand loyalty include:

- Working relationships. The fleet may have acquired trucks from the manufacturer over multiple replacement cycles and the fleet feels the manufacturer has treated them well.
- Experience indicates the manufacturer's trucks are more reliable.
- Problems with other manufacturers. The fleet has experienced problems with one manufacturer's trucks and has transitioned to a new manufacturer.

In some cases, brand loyalty is so strong as to overrule all suggestions to try other manufacturers. Sometimes a fleet will hire a new fleet decision maker who, if they have enough authority, can switch the fleets decision making, including a simple switch of loyalty to their manufacturer of choice.

Prevalence of maintenance as a determinant

Most fleets discuss maintenance as an important decision determinant. Fleets generally keep maintenance records and are aware of trucks that have significant repairs or are out-of-service more often or longer than expected. Maintenance is often used as a stand-alone determinant in retirement and a contributing determinant in acquisition decisions. Many fleets will typically use either a fixed mileage thresholds or excessive maintenance incidence/cost to indicate when to retire a truck. For those who do not use a mileage heuristic, maintenance costs or downtime will generally determine truck retirement. Sometimes a fleet will compare maintenance costs with the depreciated truck value to make a retirement determination. For others, it is much simpler: when a truck seems too expensive to continue repair; retire it.

Impact of driver shortage

Fleets indicated there has been a driver shortage for the past few years. The COVID-19 pandemic exacerbated this shortage. Fleets often stated drivers are their most valuable asset and these fleet decision makers consider feedback from their drivers when making decisions about truck acquisitions. Hiring and retaining drivers can be difficult, so fleets will act to retain drivers. Some effects of this driver shortage on truck acquisition and retirement decisions are:

- Turn trucks over faster so the fleet average truck age newer. Drivers prefer newer trucks so fleets will move to shorter leases if possible or retire owned trucks somewhat sooner.
- Buying specific truck classes. Some fleets will attempt to operate with only medium-duty trucks to avoid requiring drivers to have CDLs. The labor rate for drivers with CDLs is higher, and those drivers are more difficult to find and hire.
- Safety is often mentioned as a key concern for fleets, and safer trucks may keep drivers longer.
- Limitations on fleet size. If a fleet cannot hire enough drivers, growth is adversely impacted. Fleets may wish to expand, but the driver shortage constrains their ability to operate more trucks.

Episodic Events

Discrete events can have major effects on the trucking industry. Recently the COVID-19 pandemic created problems with the manufacturing supply chain and with the number of available drivers. The supply chain backup caused delays in production of new trucks, and truck driver schools shut down lowering the number of new drivers. Fleets report acquiring whatever suitable truck was available rather than a truck matching a desired specification. Larger fleets report ordering more trucks and get preferential treatment over single truck orders from smaller fleets when trucks do become available. In some cases, fleets changed their normal acquisition procedures by switching to leasing or from used to new trucks. Some fleets saw the demand for their services increase due to the pandemic, but their normal response to acquire more trucks to meet such an increase was hampered because of truck supply disruptions.

Regulation

Emissions regulations affecting trucks in starting in model year 2010 were another episode with broad effects. Uncertainty around the reliability of new engines and emissions systems caused some fleets to accelerate acquisitions of trucks prior to the arrival of the new technologies and caused other fleets to delay truck retirements in the few years following. Reports of poor performance, reliability, and added maintenance costs—often attached to the DEF systems to reduce NO_x emissions—rippled through fleets for years. The episode was the origin of many interviewees' accounts in which truck manufacturers' reputations for reliability and maintenance costs were won or lost.

Regulations beyond statewide emissions limits and technology mandates can significantly affect fleet acquisition and retirement decisions in a variety of ways. In some cases, fleets adjust their fleet composition, i.e., what trucks they acquire and retire. In other cases, fleets delay such changes by holding on their trucks longer, i.e., extending turnover cycles.

- Port specific policies. Fleets mentioned turning their trucks over faster than ordinary to meet the California port requirements. They expect to do so again in the near- to mid-term.
- AB-5. The change in the status of independent contractors may require fleets to convert contract drivers to employees. In doing so fleets may have to change the number of trucks they own or lease. Some fleets suggested that independent drivers may leave the state or leave trucking because they do not wish to be employees.
- Financial Accounting Standards Board (FASB) rules. The FASB changed how companies report equipment leases. As a result, some companies switched from leasing to purchasing new vehicles. However, as the rules are still coming into full effect, the long-term effects on fleets leasing trucks are unknown.

Alternative Fuel Truck Conclusions

The subset of fleet interviews used for the analysis of fleet consideration of alternative fuel trucks revealed 58 mentions of determinants of acquiring AFTs: 36 negatives and 22 positives.

- For every alternative fuel truck type (BET, FCET and, NGT)) interviewees mentioned more negative determinants (barriers) than positive determinants (motivations).
- BETs garnered the most discussion of determinants while FCETs garnered the least. This may reflect the present overall higher salience of BETs and lower awareness and consideration of FCETs. That is, the number of determinants discussed for each alternative may reflect comparative, present-day, top-of-mind awareness rather than substantively different assessments of the alternatives.

- No intrinsic performance capability of either electric or natural gas truck technology is discussed by more than a few fleets as a positive determinant of their consideration or acquisition of BETs or FCETs.

Both BET and NGT discussions contained contradictions in what was considered a positive or negative determinant.

- For BETs, maintenance, torque/power, and grant and incentive programs were discussed as both positive and negative determinants.
    - BETs were seen as having lower routine maintenance costs. However, the possible need to replace the battery discouraged others from considering BETs.
    - Fleets were generally in favor of the increased torque and power of electric trucks. However, in one fleet the additional torque of electric trucks was viewed as a negative: drivers disliked the handling characteristics of the electric truck-trailer combination.
    - Finally, grant and incentive programs were seen as strong motivators for BET purchases. However, three interviewees mentioned difficulties in applying for them. Such difficulties can cause some fleets to be excluded from accessing these motivating features, demonstrating the importance of careful incentive design.
- For NGTs, fueling infrastructure, costs, and incentives were reported both positively and negatively.
    - While natural gas fueling infrastructure was the most reported barrier, fleets operating in short-haul applications that had sufficient infrastructure in their operating region or who were able to install their own fueling stations saw fueling infrastructure as a benefit.
    - That costs were reported positively and negatively may be attributable to differences in NGT manufacturers, use-cases, cost calculation methods, fuel suppliers, regions, etc., as well as which diesel truck it is being compared. Like BETs, incentives for NGTs were seen positively and negatively.
    - The negative view of incentives was partially due to the shift away from incentivizing NGTs and towards zero-emission technologies. This left fleets feeling like they had been left stranded after having invested in NGTs and supporting infrastructure. Some fleets reported concerns that could happen again if they were to invest in zero-emission trucks.

Drivers were reported as having a large influence on alternative fuel truck acquisition decisions. The positive and negative views of drivers about each truck type (BET, NGT, FCEV) and their performance, e.g., range, torque, noise, vibrations, were mentioned in several interviews.

Summary Quantitative Results

Results from the interviews and surveys allow us to make certain quantitative statements about the behavior of the fleets in this study when they acquire or retire trucks. Table14 shows the number and percentage of fleets exhibiting the following behaviors with respect to their acquisition and retirement of trucks. These statements refer specifically to the modest number of fleets interviewed in the study and are not intended to be representative of fleets in general.

Table 14 Prevalence of the Determinants Brand Loyalty, Maintenance Cost, Vehicle Miles, Vehicle Age, Fuel Costs, TCO as well as Zero Emission Truck Consideration, number and percent

	Maintenance Cost	Vehicle Miles	Brand Loyalty	Fuel Costs	Vehicle Age	TCO	Seriously Considering ZETs
Number of Fleets	59	36	29	24	16	13	32
Percentage of Fleets	72%	44%	35%	29%	20%	16%	39%

Total n = 82.

Maintenance cost: Use maintenance cost as a trigger for deciding whether to retire trucks.
Vehicle miles: Use vehicle miles as a trigger for truck retirement.
Brand loyalty: Committed to acquiring trucks from the same manufacturer(s) over time.
Fuel costs (economy): Vehicle fuel costs (economy) are a determinant in the purchase or retirement decisions.
Vehicle age: Use vehicle age as a trigger for deciding whether to retire trucks.
TCO: Calculate and consider a metric that combines several cost components of owning and operating trucks.
Seriously considering ZEVs: Some fleets may or may not have purchased a ZEV truck, but in their pre-interview questionnaires they indicated they are "seriously considering" purchasing one, though usually subject to some condition such as availability of a truck that can complete the fleets existing duty cycle such as longer range, the prior creation of a network of charging, or lower truck prices.

The practice of using TCO or a TCO-like summary metric of costs is observed almost solely among large fleets in the sample. All but one of the fleets stating they calculate and consider a metric that combines several cost components of owning and operating trucks have at least 200 trucks in their fleet. The sole exception has five trucks in their fleet.

Fleets operate trucks in a variety of applications some of which are considered more favorable for incorporating ZEVs. Trucks used to provide short-haul and drayage services have shorter expected daily driving distances and/or a practice of returning to a central depot every day. Long-haul trucks have a much longer driving distances between pickup and delivery of their cargos than do short-haul or drayage trucks. Further, long-haul trucks fuel at widely spaced fueling stations. For these reasons, short-haul and drayage trucks may be better candidates for truck electrification than trucks used in long-haul applications.

In Table 15 we select fleets that only serve long-haul, drayage, or a combination of short-haul and drayage applications and ask whether those fleets have seriously considered ZETs. Note these are all heavy-duty trucks. Fleets that only operate trucks that have relatively short ranges (drayage and short-haul) show a greater likelihood of seriously considering ZETs. We note ports are imposing rules that require truck electrification, and we might reasonably expect the percentage of firms seriously considering ZETs should be even higher than it is.

Table 15 Fleets serving only long-haul, drayage, or a combination of drayage and short-haul applications that have seriously considered acquiring ZEVs, percent.

	Fleets containing trucks in only these applications:		
	Long-haul	**Drayage**	**Drayage and Short-haul**
Percentage of fleets seriously considering ZEVs	24%	44%	40%

RECOMMENDATIONS

Recommendations offered here are narrowly focused on extensions of and improvements to the research.

Sampling design

The sampling design did not distinguish between use cases for medium-duty trucks; future work should do so. Some fleets have conflicting assignments in the sampling typology. One example of this is we have reports from fleets of medium-duty trucks used in long-haul applications which is so different from short-haul and pickup-and-delivery that different determinants may apply to medium-duty trucks in the different use cases. We note this point only became apparent once we started interviewing fleets. Grouping medium-duty trucks into a single use category was written into the RFP for this project. No reason to question the classification of medium-duty trucks into one "all use cases" category was revealed until fleet decision makers started telling us about how they use their trucks.

Further, the categorization of fleets into small, medium, and large based on number of vehicles has no consistent basis in the literature. Different data sources on fleets use different cut-points between categories. For any one research question, the best choice may not be any of the available options. The need to achieve the best result within any single study would have to be balanced against the comparability of its results to any or all other studies which use a fleet size measure.

Fleet Decision Making

What do fleets have the power to decide? How are their choices proscribed by external factors such as truck availability and policy, episodic events, and even the circumstances of a single transaction? In social science terms, these are questions of structure versus agency. How much freedom to act does a fleet have vs. how much are its actions proscribed by forces outside its direct control? One specific example would be continuing study of the role of truck leasing: to what extent do leasing companies facilitate versus proscribe fleets' truck choices? Though it appears only indirectly in the results and conclusions of this report, one interview with a large truck leasing company revealed they treat fuel economy differently as a determinant for the trucks they acquire to operate themselves vs. the trucks they lease to other fleets. Fuel economy is an important determinant in decision making regarding the trucks they purchase for their own use but is not used in purchasing trucks they will lease to other fleets. If some of those fleets leasing these trucks believe fuel economy is not a useful determinant in their truck acquisition decisions, how much is that belief shaped by the trucks they are offered when they lease?

Much of how fleets describe their decision-making is inward looking, i.e., they are not using data from the thousands of similar vehicles on the road operated by other fleets. Further, much of what fleets told us about their truck turnover decisions reveals they are conservative in the sense of attempting to preserve established business practices. We heard examples of these practices being disturbed and changed by internal factors, e.g., the hiring of a new manager with sufficient authority to change how a fleet operates, their relationships with external actors, e.g., the discontinuance of a desired truck model by a manufacturer, and external factors broadly affecting the entire freight sector (or more, in the case of COVID-19). Even in describing their adaptations though, fleets' descriptions often sound like an effort to establish a new normal, a new set of routines that would be as resistant to change as the routines they are replacing.

Under such conditions, how can a large, growing, and diverse variety of fleets be prompted to consider changes they perceive to be as dramatic as alternative fuels? Does consideration of a new type of truck, such as alternative fuel trucks which have different performance characteristics, require a new way of thinking about acquiring and retiring trucks? Those few fleets—ranging in size from owner-operators of a single truck up to the largest, most diverse organizations represented in this study—whose truck turnover decisions are proactive, who manage their business with an openness to change and experimentation may play an outsize importance in transitions. What programs, processes, or policies can build on their willingness to experiment to engage freight providers broadly?

Additional information from truck drivers about their response to alternative fuel trucks—and whether drivers' influence on fleet consideration of alternative fuel trucks is different from their influence on fleets' acquisition of conventionally fueled trucks—requires more research. One idea to emerge from discussions of electric trucks is whether there are direct health benefits to truck drivers, from truck electrification. This seems most certain to be true based on reduced exposure to tailpipe emissions and while speculative, possibly also based on reduced exposure to vibration and noise over the course of many hours of daily operation over months and years.

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GLOSSARY OF TERMS, ABBREVIATIONS, AND SYMBOLS

AB- Assembly Bill
AC- Air conditioning
AFV- Alternative Fuel Vehicle
APU- Auxiliary Power Unit
AQMD- Air Quality Management District
ATA- American Trucking Association
B10- 10% biodiesel blend
B20- 20% biodiesel blend
B5- 5% biodiesel blend
BET- Battery Electric Truck
BEV- Battery Electric Vehicle
BIT- Basic Inspection Terminals (inspection)
CAAP- Clean Air Action Plan
CARB- California Air Resources Board
CDL- Commercial Driver's License
CEO- Chief Executive Officer
CFO- Chief Financial Officer
CNG- Compressed Natural Gas
COO- Chief Operating Officer
CPM- Cost Per Mile
CSA- Compliance, safety, accountability
CTA- California Trucking Association
CTM- Corporate Transportation Manager
DCP- Dedicated carrier partner
DDC- Detroit Diesel Corporation
DEF- Diesel Emission Fluid
DMV- Department of Motor Vehicles
DOT- Department of Transportation
ELD- Electronic Logging Device
EPA- Environmental Protection Agency
zepto- Electric Power Takeoff
ESG- Environmental, Social, and Governance
eTRU- Electric Transport Refrigeration Unit
EV- Electric Vehicle
FASB- Financial Accounting Standards Board
FCET- Fuel Cell Electric Truck
FCEV- Fuel Cell Electric Vehicle
FTL- Full truckload
GHG- Greenhouse gas
GM- General Motors
GVWR- Gross Vehicle Weight Rating
HDV- Heavy-duty vehicle
HEV- Hybrid Electric Vehicle
HVAC- Heating, ventilation, and air conditioning
HVIP- Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project

ICCT- International Council on Clean Transportation
ICE- Internal Combustion Engine
ISO- International Organization for Standardization (tanks designed to carry bulk liquids)
LDV- Light-duty Vehicle
LLC- Limited Liability Company
LNG- Liquefied Natural Gas
LTL- Less than truckload
MBA- Master of Business Administration
MDV- Medium-duty vehicle
MHDV- Medium- and Heavy-duty vehicle
NACFE- North American Council for Freight Efficiency
NGT- Natural Gas Truck
NHTSA- National Highway Traffic Safety Administration
NOx- Nitrous Oxide
OEM- Original Equipment Manufacturer
OTR- Over-the-road
PHEV- Plug-in Hybrid Electric Vehicle
PO- Purchase order
RNG- Renewable Natural Gas
ROI- Return on Investment
SKU- Stock Keeping Unit
SOx- Sulfur Oxide
TCO- Total Cost of Ownership
TRU- Transport Refrigeration Unit
UCLA- University of California, Los Angeles
ZET- Zero-Emission Truck (including battery electric and fuel cell electric trucks)
ZEV- Zero-emission vehicle (including battery electric and fuel cell electric vehicles)

APPENDIX A: PRE-INTERVIEW QUESTIONNAIRE

Welcome and thank you for helping us understand how fleets operate. We created this questionnaire so you can provide us with some basic background about your company to prepare us for our upcoming conversation. We estimate it will take less than 10 minutes of your time.

1. Please provide your following contact information:
   Name: ____
   Company: ____
   Job Title: ____
   Email Address: ____

2. Do you buy or lease trucks for your fleet?
   ❑ Yes
   ❑ No

3. If you don't buy or lease trucks for your fleet, who does
   Name: ____
   Email: ____

4. Do you make decisions about the selling and/or scrapping Medium- or heavy-duty trucks?
   ❑ Yes
   ❑ No

5. If you don't make decisions about the selling and/or scrapping Medium- or heavy-duty trucks, who does?
   Name: ____
   Email: ____

6. Are truck purchase and lease decisions for your fleet made by a single person or by a single office in your organization?
   ❑ Yes
   ❑ No

7. Are you a driver-owner of a truck or fleet of trucks?
   ❑ Yes
   ❑ No

8. Are there policies, requirements, or guidelines that assure a level of consistency in truck purchase and leases across these multiple offices or locations?
   ❑ Yes
   ❑ No

9. What is the fleet's vehicle ownership model?
   ❑ Central fleet owned

❑ Driver-owner
❑ Mixed
❑ Other (please specify): ____

10. If the ownership model is mixed, what is the percentage of each (sum should equal100)?
❑ Central fleet owned _________
❑ Driver-owner ________________

11. What is the approximate total number of trucks in your fleet?
____

12. What classes of trucks are in your fleet (check all that apply)?
❑ Class 2b — 8,501 to 10,000 pounds
❑ Class 3 — 10,001 to 14,000 pounds
❑ Class 4 — 14,001 to 16,000 pounds
❑ Class 5 — 16,001 to 19,500 pounds
❑ Class 6 — 19,501 to 26,000 pounds
❑ Class 7 — 26,001 to 33,000 pounds
❑ Class 8 — 33,001 or heavier
❑ Other (please specify):____

13. What are your trucks used for (please check all that apply)?
❑ Heavy Duty (Long-haul, line haul) → Interstate or Intrastate
❑ Heavy Duty (Short haul, day truck) → Drayage, Pick-up, and Delivery
❑ Heavy Duty (Vocational with Power Take Off)
❑ Medium-duty (Delivery)
❑ Medium-duty (Vocational with Power Take Off)

The following questions pertain to your **Heavy Duty (Long-haul, line haul) → Interstate or Intrastate)** trucks. If you do not have these trucks, please proceed to the following section.

14. In general, how many drivers operate a **Heavy Duty (Long-haul, line haul) → Interstate or Intrastate** truck in a single day?
____

15. On average, how many hours is a **Heavy Duty (Long-haul, line haul) → Interstate or Intrastate** truck in use each day?
Minimum hours: ____
Maximum hours: ____

16. Where do **Heavy Duty (Long-haul, line haul) → Interstate or Intrastate** trucks refuel (check all that apply)?

❑ Central depot
❑ Public stations/ Truck stops
❑ Driver’s home
❑ Other (please specify):____

17. At the end of the last shift, where do **Heavy Duty (Long-haul, line haul) → Interstate or Intrastate** trucks reside (check all that apply)?
❑ Single, central depot
❑ Multiple depots/ Locations
❑ Other (please specify):____

The following questions pertain to your **Heavy Duty (Short-haul, day truck) → Drayage, Pick-up, and Delivery** trucks. If you do not have these trucks, please proceed to the following section.

18. In general, how many drivers operate a **Heavy Duty (Short haul, day truck) → Drayage, Pick-up, and Delivery** truck in a single day?
____

19. On average, how many hours is a **Heavy Duty (Short haul, day truck) → Drayage, Pick-up, and Delivery** truck in use each day?
Minimum hours: ____
Maximum hours: ____

20. Where do **Heavy Duty (Short haul, day truck) → Drayage, Pick-up and Delivery** trucks refuel (check all that apply)?
❑ Central depot
❑ Public stations/ Truck stops
❑ Driver’s home
❑ Other (please specify):____

21. At the end of the last shift, where do **Heavy Duty (Short haul, day truck) → Drayage, Pick-up and Delivery** trucks reside (check all that apply)?
❑ Single, central depot
❑ Multiple depots/ Locations
❑ Other (please specify):____

The following questions pertain to your **Heavy Duty (Vocational with Power Take Off)** trucks. If you do not have these trucks, please proceed to the following section.

22. In general, how many drivers operate a **Heavy Duty (Vocational with Power Take Off)** truck in a single day?
____

23. On average, how many hours is a **Heavy Duty (Vocational with Power Take Off)** truck in use each day?
    Minimum hours: ____
    Maximum hours: ____

24. Where do **Heavy Duty (Vocational with Power Take Off)** trucks refuel (check all that apply)?
    ❑ Central depot
    ❑ Public stations/ Truck stops
    ❑ Driver's home
    ❑ Other (please specify):____

25. At the end of the last shift, where do **Heavy Duty (Vocational with Power Take Off)** trucks reside (check all that apply)?
    ❑ Single, central depot
    ❑ Multiple depots/ Locations
    ❑ Other (please specify):____

The following questions pertain to your **Medium-duty (Delivery)** trucks. If you do not have these trucks, please proceed to the following section.

26. In general, how many drivers operate a **Medium- Duty (Delivery)** truck in a single day?
    ____

27. On average, how many hours is a **Medium- Duty (Delivery)** truck in use each day?

    Minimum hours: ____
    Maximum hours: ____

28. Where do **Medium- Duty (Delivery)** trucks refuel (check all that apply)? ❑ Central depot
    ❑ Public stations/ Truck stops
    ❑ Driver's home
    ❑ Other (please specify):____

29. At the end of the last shift, where do **Medium- Duty (Delivery)** trucks reside (check all that apply)?
    ❑ Single, central depot
    ❑ Multiple depots/ Locations
    ❑ Other (please specify):____

The following questions pertain to your **Medium- Duty (Vocational with Power Take Off)** trucks. If you do not have these trucks, please proceed to the following section.

30. In general, how many drivers operate a **Medium- Duty (Vocational with Power Take Off)** truck in a single day?

____

31. On average, how many hours is a **Medium- Duty (Vocational with Power Take Off)** truck in use each day?

Minimum hours: ____

Maximum hours: ____

32. Where do **Medium- Duty (Vocational with Power Take Off)** trucks refuel (check all that apply)?

- ❑ Central depot
- ❑ Public stations/ Truck stops
- ❑ Driver's home
- ❑ Other (please specify):____

33. At the end of the last shift, where do **Medium- Duty (Vocational with Power Take Off)** trucks reside (check all that apply)?

- ❑ Single, central depot
- ❑ Multiple depots/ Locations
- ❑ Other (please specify):____

34. Does your company purchase or lease trucks?

- ❑ Purchase only
- ❑ Lease only
- ❑ Purchase and Lease

35. Does your company purchase/lease new or used trucks?

- ❑ New only
- ❑ Used only
- ❑ New and used

36. Which of the following types of vehicles is your fleet **currently operating** (check all that apply)?

- ❑ Diesel
- ❑ Gasoline
- ❑ Natural Gas (CNG/LNG)
- ❑ Hybrid
- ❑ Electric: Plug-in hybrid (PHEV), Battery electric (BEV)
- ❑ Fuel cell (Hydrogen)

❑ Other (please specify): ____

37. Has your fleet previously **operated and discontinued** the use of trucks that use a fuel that is not diesel or gasoline?

❑ Yes
❑ No

38. If your fleet previously **operated and discontinued** the use of trucks that use a fuel that is not diesel or gasoline, which types did you use (check all that apply)?

❑ Natural Gas (CNG/LNG)
❑ Hybrid
❑ Electric: Plug-in hybrid (PHEV), Battery electric (BEV)
❑ Fuel cell (Hydrogen
❑ Other (please specify):____

39. Is your fleet **seriously considering** trucks that use a fuel that is not diesel or gasoline now or in the immediate future?

❑ Yes
❑ No

40. If your fleet is **seriously considering** trucks that use a fuel that is not diesel or gasoline now or in the immediate future, which types (check all that apply)?

❑ Natural Gas (CNG/LNG)
❑ Hybrid
❑ Electric: Plug-in hybrid (PHEV), Battery electric (BEV)
❑ Fuel cell (Hydrogen)
❑ Other (please specify): ____

41. If your fleet is **already using alternative fuels**, is your fleet **seriously considering** trucks that use **other alternative fuels** that you are not already using?

❑ Yes
❑ No

42.If your fleet is **already using alternative fuels** ,and **seriously considering** trucks that use **other alternative fuels** that you are not already using, which types (check all that apply)?

❑ Natural Gas (CNG/LNG)
❑ Hybrid
❑ Electric: Plug-in hybrid (PHEV), Battery electric (BEV)
❑ Fuel cell (Hydrogen)
❑ Other (please specify): ____

APPENDIX B: FLEET INTERVIEW PROTOCOL

Note the protocol is not a list of questions that must be asked. Questions in *italics* are suggested language for introductions and transitions. The questions highlighted in **bold** are the essential topics. Topics and questions in plain format are suggestions for prompts or follow-ups should they be required. Different protocols were prepared for interviews with truck manufacturers, consultants, and other third parties. Those protocols are not included in this report. They are patterned on this fleet protocol.

Preliminaries

Reminders for Interviewers

- Minimize interviewer-to-interviewer exchanges—let the interviewee do most of the talking.
- If interview is disrupted or ends prematurely, ask to follow up later.
- If another individual is highlighted in the interview as the person who is most knowledgeable or someone we should talk to, ask for their contact info or for the interviewee to reach out to them on our behalf.

Rapport Building with Interviewee

- Introduce everyone on call; confirm interviewee by name
- Explain (remind) who we are and why we are there:
  We are researchers at the Institute of Transportation Studies at UC Davis. This work is being paid for by CARB. Our goal with these interviews is to help them (state of CA/ CARB) better understand how trucks turn over in the fleet sector, and in particular, the issues in buying and selling trucks.
- Be gracious.
  Thank you for agreeing to be interviewed today. We value your knowledge, experience, and opinions, and we also recognize you are very busy, and your time is valuable. Consequently, we will be as brief as possible.
- Gain consent for interview and recording
  We would like to record the interviews just to make sure we get everything you're saying. The only people who will have access to the interviews are members of the research team. Are you ok if we record?

Confirm Fleet Information (from questionnaire)

I know we touched base on some of this in the pre-survey, but just to make sure we're all on the same page, we have your fleet down as (short, concise fleet description prepped by interviewer). Do I have that right?

- Make sure to cover:
  - Fleet Size:
  - Fleet vehicles (relative amounts of each):
  - Typical day-to-day operations:

With respect to purchasing/leasing and retiring trucks, what is your role in the company?

- Make sure to cover:
  - Their specific role:

You mentioned you [repeat their description back], are there any other people or groups of people, e.g., departments, boards, etc. who are involved in these decision-making processes?

- Make sure to cover:
  - Who else is involved in the decision-making process?

You said you're [insert role]. Regarding decision making about [purchasing/leasing/retirement], how much control do you have within each one of those?

- Make sure to cover:
  - Type of decision-making structure: hierarchical, siloed, group

Truck Turnover

Now that we have a sense of how things work and what you're involved in, we're going to ask you to walk us through a few situations where you [purchased/leased/retired/scrapped] a truck.

First, can you walk us through your most recent purchasing process?

- Make sure to cover:
    - **What are the factors involved?**
        - **How are they used?**
        - **Who is involved?**
    - Why was this truck being purchased?
    - How does this truck fit into the overall fleet operations?
    - Who did you purchase it from?
        - Manufacturer/dealer:
        - What is your history with this supplier?
    - Are there any policies that impact the purchasing process?
    - What factors were considered when deciding which vehicle to purchase?
        - Make sure these factors are EXPLICIT (e.g., "TCO"-- what goes into their TCO?)
            - How do these factors weigh into your decision?
            - How do you track these factors? (manufacturer reported, telematics, other fleets, etc.)
            - Is this something that changes? How often and why?
            - Do they include any economic factors? (payback period, net present value, etc.)
            - Do you consider facility changes:
            - Do you consider driver satisfaction and experience?
    - TCO (if not mentioned explicitly probe: Did you consider TCO?:)
        - What factors do you consider as TCO?
    - What uncertainties were there and to what extent were they an issue? (maybe give them a particular issue and ask how they think about this)
    - Can you give me an example of how the procedure for selling, or scrapping trucks has changed?
        - What caused this?

Now switching gears to truck retirement or scrappage, can you walk us through your most recent retirement/scrappage process?

- Make sure to cover:
  - **What are the factors involved?**
    - **How are they used?**
    - **Who is involved?**
  - What truck was being retired? Why?
  - How does this truck fit into the overall fleet operations?
  - What does the fleet do with the vehicles when they are retired? Where do they go?
    - If they sell them, where (back to OEM)? What are they used for?
  - How do you/they decide to retire vs scrap?
  - Who was involved in the process?
  - Are there any policies that impact the retirement/scrappage process?
  - What factors were considered when deciding to retire the vehicle?
    - Is this something that changes? How often and why?
    - Does it include any economic factors? (payback period, net present value, etc.)
  - Did you consider driver satisfaction and experience?
  - TCO (if not mentioned explicitly probe: Did you consider TCO?:)
    - What factors do you consider as TCO?
  - What uncertainties were there and to what extent were they an issue? (maybe give them a particular issue and ask how they think about this)
  - Are vehicles ever retired ahead of schedule? What causes this?
- Can you give me an example of how the procedure for selling, or scrapping trucks has changed?
  - What caused this?

Purchasing AFVs (hydrogen, electricity, (R)NG)

For fleets with AFVs

- **What are the factors involved?**
    - **Are they different for AFVs?**
    - **Are they used differently?**
    - **Who is involved? Anyone different?**
- You indicated you have ---, how many trucks of this fuel type do you have?
- What role does --- play in the overall fleet story?
- How did you make the decision to purchase ----- vehicles?
    - Were there any differences between the purchase process for these and conventional vehicles?
    - How did you decide which type of AFV you were going to use?
    - Do driver experiences influence decisions to purchase AFVs?
- How were you originally introduced to the idea of using -----?
    - Did you work with any other organizations or other resources to get information?
    - Do you wish there were additional sources of information?
- What has prevented these vehicles from playing a larger role in the overall fleet?
    - What uncertainties are there and to what extent are they an issue? (ex: infrastructure, range, reliability)
        - Are there any absolute barriers? (Barriers that they absolutely can't purchase them)
        - What could motivate you to purchase an AFV even with these uncertainties?
    - Have you needed to make any changes to your operational schedules to utilize these vehicles?
        - Is this something you would be willing to do if needed?
    - How have you handled charging and other new infrastructure needs?
        - How has access to charging been at both your facilities and on longer routes?
- Are you planning on purchasing additional AFVs for your fleet?
    - If "Yes" □
        - Would you purchase more of the same AFVs? or different AFVs? Why?
        - What percentage of AFVs would you like to see in your fleet?
    - If "No" □
        - Why not?
        - What would make you more likely to purchase another AFV?

For fleets without AFVs

- **What changes would need to be made to view the AFV purchase more positively?**
    - **Are these factors different?**
    - **Are the factors used differently?**
    - **Who is involved? Anyone different?**
        - **Who would have to say it is only to acquire an AFV?**
- Has the fleet considered purchasing any electric trucks? Which ones?
    - If YES →

        - How were you originally introduced to the idea of using an electric truck?
        - Did/will you have to change anything about your acquisition process? Did/will the process look the same?
            - Make sure to cover:
                - Who would have to be involved in the process?
                - Which determinants would be involved?
                - What information would be needed?

    - If NO →
        - If you were going to buy or lease an electric truck, would you have to change anything about your acquisition process? Would the process look the same?
            - Make sure to cover:
                - Who would have to be involved in the process
                - Which determinants would be involved?
                - What information would be needed?

- What would motivate (you/your fleet) to purchase an electric truck?
- What would prevent you from adopting them?
    - What uncertainties are there and to what extent are they an issue? (ex: infrastructure, range, reliability)
    - Are there any absolute barriers? (Barriers that they absolutely can't purchase them)
    - Would you be willing to make changes to your operational schedules to help utilize AFVs?

Fleet Evolution

- Do you think there will be any significant changes in the way you purchase vehicles in the future?
    - Will upcoming mandates and regulations affect your purchasing process? (ZEV mandate)
        - Have you started preparing for this/ thinking about how you will handle it?
        - Note: Do they now purchase used vehicles, utilize aftermarket treatments, keep vehicles for longer, repower vehicles, buying out of state, moving out of California, or purchase vehicles in advance to avoid regulations? (This may be revealed as part of what they did to respond to regulations in the past)
    - Will this have any significant effects on the fleet composition?
    - Are there other changes coming from within the fleet or from outside regulations?

Outro

- Do you have any questions for us?
- Incentive details:'.
- Reminder about promised info (contact info for other person at company, organizational chart, policy, etc.)
- Thank you for your time.

APPENDIX C: FLEET INTERVIEW SUMMARIES

Summaries are presented for interviews with fleets; interviews with manufacturers, consultants, and leasing companies are not included. Each summary starts with information on the fleet required to place it within the sampling framework and some basic operational descriptions. *Keywords* are assigned to the fleet as an intermediate analytical step, i.e., after the interview transcript has been coded. The summaries address the research questions: what are the determinants of truck turnover and how are the determinants used? The summaries also provide examples to support the selection of keywords.

Note that numbering is not consecutive as interviews with non-fleet entities were interspersed among the fleet interviews. However, these fleet summaries are presented in the order interviews were conducted.

Summaries start on the following page.

Interview Summary for Fleet Number: 01

1. **Region:** National
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 70 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Short-haul, Long-Haul
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** Diesel-propane hybrid (discontinued)

Keywords
Decision Making Structure: Siloed
Adaptability: Proactive
Complexity: Complex

Summary

Fleet 1 is a family-owned general commodities fleet operating long-haul routes throughout the United States. Acquisition decisions are made by the interviewee and his sister-in-law. The interviewee is the primary decision-maker around what trucks to acquire while the sister-in-law makes decisions around whether to purchase or lease. They recently acquired 15 new trucks to expand their fleet because of high demands.

Truck acquisition decisions are centered around improving fuel economy with downsped engines. The interviewee is very involved in working with the manufacturer (Volvo) on customizing their spec. Fleet 1 is driven to create the most fuel-efficient spec to prove that the vehicles can be made fuel-efficient, environmentally-friendly, and economic despite others in the industry saying it is impossible. Fleet 1 has investigated other manufacturers and always benchmarks their trucks against others they demonstrate but has always gone back to Volvo because Volvo has the best fuel economy of the trucks that Fleet 1 drivers are willing to use. Fleet 1 prefers using the most efficient trucks rather than relying on drivers to drive efficiently since drivers are paid by the mile and thus incentivized to drive faster to optimize their pay.

Fleet 1 previously made their own diesel-propane hybrid trucks which proved to be more fuel-efficient, however too expensive. Fleet 1 is now looking into a diesel-electric hybrid to increase efficiency but is concerned about the high costs and lack of infrastructure. The interviewee stated that he "loves the challenge" of meeting the California ZEV regulations. His goal is to educate other fleets about the process and benefits of becoming more fuel-efficient, and he does so by speaking with fleets and hosting a radio show.

At the same time, the interviewee recognizes that his personal desire to maximize fuel economy must be balanced against the need to acquire trucks that keep existing drivers and help recruit new drivers. He notes that, "the most efficient truck in the world isn't worth a damn if the driver won't drive it." He reports that nearly all freight companies pay their drivers the same wages, so drivers look to the truck types to decide where they want to work. Returning to his earlier point about drivers being paid by the mile, he believes drivers look for newer and faster trucks. Driver preferences for new trucks also factor into their truck turnover decisions, opting to retire trucks when they get too old for drivers to want to use them. Other retirement and turnover factors include resale value. To determine how long to keep the trucks, Fleet 1 works with their maintenance shop to track maintenance expenses and resale value.

Interview Summary for Fleet Number: 02

1. **Region:** National (occasionally Canada)
2. **Ownership Model:** Owner-operator
3. **Fleet size:** 5 trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Short-haul, Long-Haul
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New and used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Mixed
Complexity: Complex

<u>*Summary*</u>
Fleet 2 is an owner-operated fleet that has been in business for the last four years. The fleet is made up of five Class 8 trucks, with one driver per truck, and engages in intrastate and interstate long-haul freight transport-- full truckload (FTL), less than truckload (LTL), and power only. Three of the trucks are leased to a larger fleet. The trucks are refueled at multiple depots and trucks overnight at multiple locations. The fleet has grown over the last few years due to strong increases in demand.

The owner makes decisions about acquiring and retiring trucks. He *purchases* new and used trucks but never leases. He has not run any alternative fuel trucks, nor is he interested in doing so. He is, however, incredibly motivated by fuel economy. He also considers resale value and insurance, but the most pressing factor is maximizing the fuel economy improvements per dollar spent. He says they look at TCO for different timeframes and then try to choose the truck with the lowest TCO, but that's not always the case.

He bought his first super fuel-efficient truck as a proof of concept and used it himself before passing them onto other drivers in the fleet. He strongly believes in helping educate the drivers in his fleet and others about the benefits of increased fuel economy.

In 2010, he bought his first Volvo and his business was born. The original truck was traded for a newer truck in 2013. In 2016, after much research on fuel mileage, reliability, and overall cost of ownership, he upgraded to a Mack Pinnacle. Next came two Mack Anthems, and once that "love affair began," he traded the Pinnacle for another Anthem. He has chronicled his fuel economy journey on social media where he engaged directly with Mack Trucks. His fourth truck was a new Mack Anthem with custom specs, and he continues to chronicle its fuel economy journey on social media accounts, but also for Mack corporate office (for research and development). The recent high demand driven by COVID led him to make his first "on lot" purchase where he was forced to choose from what was available. The interviewee is in the process of ordering two more Mack trucks.

He has only retired two trucks. One was in an accident and needed to be sold. Because the new replacement truck was significantly better, he bought another so the second driver wouldn't feel left out (he retired the second driver’s truck prematurely to facilitate this transaction). The motive for these new purchases was to keep his drivers happy. Driver retention was cited as important because of a general shortage of drivers in the industry. He is hoping to have his trucks on a five-year trade cycle to maximize their TCO.

The interviewee says that drivers of alternative fuel trucks (specifically, natural gas trucks) have a lot of complaints. Things aren’t as “rock solid,” and it’s harder to find fuel so they “have to pay attention to where you are and what your fuel status is.”

He believes his fleet is too small, and he cannot afford the high upfront costs of AFVs. He also believes that they wouldn’t work well for his application (long-haul) because natural gas is too hard to find. He is aware of the technology and had a chance to watch Volvo build an electric truck, but still thinks the technology isn’t there yet. Emissions reductions are fine, but not a strong enough reason to switch. He believes electric trucks are simpler, a great alternative, and that “we’ll get there eventually.” The “we” is the big collective “we” of truck makers, and fleet operators, not just him and his company. But right now, truck stops do not offer charging, which limits where he can go. Both purchase costs and infrastructure availability are strong barriers to adoption. He is also concerned about the impact of cold weather on the truck’s range, as it makes battery life non-viable (He’s based out of South Dakota). In addition, his drivers are not in favor of moving to any alternative fuel. Just getting them to drive an automatic transmission diesel truck was work.

Interview Summary for Fleet Number: 05

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** Over 1,000
4. **Truck type(s):** Class 8
5. **Use-case(s):** Long-haul, short-haul
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** Experimenting with electric

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: The fleet's purchase decisions were focused mainly on *sustainability, improving fuel efficiency,* and working towards *electrification*. These are all included as they work to meet their s*ustainability goals, state, and federal regulations*.

How are they used: The fleet tries to deploy alternative fuels where they can, but they are limited in the applications that an electric truck will work for.

<u>*Summary*</u>
The interviewee is currently a consultant but was formerly the fleet manager in charge of purchasing for Fleet 5, which fulfills Company 5's freight needs. Fleet 5's decisions about whether to purchase or lease trucks is based on the buying cycles which determine what is economically better decision at the time. Fleet 5 is constantly moving trucks between their different operations by increasing or decreasing the number of trucks on certain lines, allowing them to cover operations in a particular location with trucks from another.

The interviewee's focus at Fleet 5 was on improving fleet efficiency and integrating alternative fuels and electric vehicles. The organization has a strong focus on sustainability, improving fuel efficiency, and working towards electrification, which heavily influences operations. Purchases are centered around meeting sustainability goals as well as state and federal regulations. Fleet 5 is constantly looking at upcoming mandates and ensuring their trucks will be able to meet the new standards. Fleet 5's sustainability goals are driven in part by the desire to exceed those of other large name companies. In addition, Fleet 5 is focused on being as efficient as possible while adhering to strong safety requirements.

Central to the integration of alternative fuels are use cases. Fleet 5 is limited in the number of electric trucks they can deploy because of the lack of a national charging infrastructure system, the high upfront costs of electric trucks, and their overall limited availability. The interviewee notes that sleeper cabs aren't on the list of trucks that manufacturers plan to electrify soon, so they are only able to electrify their day cabs. Additionally, the high upfront costs and uncertainty of incentives for electric trucks means that the fleet must calculate the business case with and without purchase incentives, and present both sets of costs to higher level decision-makers.

When retiring a truck, Fleet 5 looks at the characteristics of the new available trucks and their finance cycles. If the newer trucks are significantly more efficient (e.g., can save money), Fleet 5 will adjust their trade cycle and replace trucks sooner. If technologies have not improved, they will wait longer to replace the trucks. Fleet 5 sells their used vehicles into the secondary market at the end of their life in their fleet.

Interview Summary for Fleet Number: 08

1. **Region:** Western U.S.
2. **Ownership Model:** Mixed (centrally owned and owner-operator)
3. **Fleet size:** 130 Company Owned, 20 Driver-Owners
4. **Truck type(s):** Class 8
5. **Use-case(s):** TRUs, grocery delivery
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** N/A

Keywords
Decision Making Structure: Hierarchical, sole
Adaptability: Mixed
Complexity: Complex

Inputs to decision-making: They have been trying to purchase more *fuel-efficient* trucks and have seen improvements. Trucks are purchased from two different brands because of the interviewee's *relationships with the manufacturers and to reduce maintenance complexity.* They have also switched manufacturers due to a *change in the length of the truck* that no longer met their requirements.

How are they used: The central fleet decided which trucks to purchase for the smaller operating companies. Truck purchases are made based on input from manufacturers, a financial consultant, drivers, and regional fleet managers.

Summary
Fleet 8 is based out of Central California and delivers to grocery stores in the Western United States. At the top, the fleet is centrally managed, but is made up of multiple regional centers, each with their own fleet manager. The interviewee works for the central fleet and is in charge of deciding which trucks to purchase for the regional fleets. The fleet managers are responsible for managing the daily operations and maintenance. Fleet 8 previously had their own in-house maintenance but sold off the business because they were increasingly needing to outsource maintenance due to the increasing complexity of the trucks. They also transitioned to leasing, which allowed them to reduce their maintenance burdens. Fleet 8 tries to always purchase warranties that last the entire 5-year lease term to help cover these costs.

The fleet has been working on increasing their fuel economy and has seen significant improvements from technology changes. They are now working on training drivers to drive more efficiently to increase savings even more.

When making purchase decisions, Fleet 8 takes input from four different groups: the manufacturers, a financial consultant, the drivers, and the regional fleet managers. Half of their trucks are purchased from Kenworth and half are from Volvo. They maintain strong relationships with both manufacturers to help with maintenance. The interviewee also works with an outside consultant who runs financial models for Fleet 8, although it is unclear what these models are or how they are used. The drivers also influence the truck purchase decisions as they need to be okay driving whatever trucks are purchased. Whenever a change is made to the type of truck purchased, the fleet conducts training to help drivers make the transition.

The interviewee noted that the regional fleet managers prefer only one truck type is used, so that it is easier to manage. The various fleet managers have different trucks and manufacturers that they prefer, but this would complicate maintenance and the fleet's relationships with the manufacturers, so they stick to two truck types.

Originally, the fleet was entirely Kenworth trucks, however, Kenworth stopped making trucks with the shorter chassis that Fleet 8 needs to run routes through Northern California. This change prompted them to switch to another manufacturer who offered a shorter chassis. Volvo was selected as they had the required truck spec with the best fuel economy. They continue to operate the Kenworth trucks on their other routes.

The interviewee has not yet tried to incorporate alternative fuel vehicles because Fleet 8 runs irregular routes, and the trucks need to be able to operate anywhere they are needed. Currently, alternative fuels are not widely available, which would limit where they can operate. Additionally, the purchase price of electric trucks is too high, and the extra weight and limited range create too many restrictions. Despite these barriers, the interviewee knew a lot about electric trucks and the Volvo LIGHTs project. He believes those trucks would work well for fleets with fixed routes, but that Fleet 8 is better off investing in fuel efficiency improvements.

The fleet used to purchase all their trucks and then resell them to the secondary market. They would keep the trucks for 8-9 years, however, they noticed that their maintenance costs were increasing rapidly. One of the dealers came to them and said that they should start replacing their trucks sooner, which caused them to switch to leasing. Most of their trucks are now leased on a 5-year cycle, with the trucks returned to the dealer at the end of the lease. While they have the option to purchase the trucks at the end of their lease, they have only done this on a few occasions. When the trucks coming off the lease have a low overall mileage and they are offered for a good buy-out value, then it makes sense for the fleet to purchase them. While purchasing the trucks off the end of the lease helps the fleet lower their monthly payments, this requires the fleet to restructure their cost, which is complicated.

Interview Summary for Fleet Number: 12

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 213
4. **Truck type(s):** Class 8
5. **Use-case(s):** Short-haul, Long-haul, Drayage
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** CNG, BEV, PHEV, FCEV

Keywords
Decision Making Structure: Siloed
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: The standard spec includes *driver comfort features, safety features,* and other factors. Vehicles meeting the spec are chosen based on *purchase price, after-sales service, reliability, duty cycle, and availability of alternative fuels.* Due to current limitations, trucks are purchased based on *availability* or which trucks have the shortest lead time.

How are they used: The central fleet creates a standard spec which is used for all six operating companies. The operating companies can choose the manufacturer. The safety features are used to lower insurance risk for the company. They are working towards becoming entirely zero emission and have purchased many alternative fuel trucks.

Summary
Fleet 12 is a central company made up of six smaller companies. Each smaller company operates in different regions, although some overlap. The interviewee works for the central company, which operates at most major U.S. seaports. Fleet 12 operates short- and long-haul businesses, but their primary work is drayage. The fleet owns about 218 trucks, but they contract with an additional 500 smaller carriers to fulfill orders. The number of trucks they own and contract with is fluid and changes based on business needs at the time. If a customer can guarantee business for a certain amount of time, they procure additional trucks to meet demand.

When making vehicle purchase decisions, the central fleet creates the same standard spec, which is used across all six companies. They ask for features like automatic transmissions, driver comfort features, and safety features. The interviewee notes that some drivers do not like some of the safety features (e.g., cameras in the truck), but that the company continues to require them because it helps protect against lawsuits and lowers insurance costs. While all six companies use the same basic specs, the smaller companies decide whether to purchase or lease, and from which manufacturer. When deciding which trucks to procure, fleets look at purchase price, after-sales service, reducing downtime from maintenance, duty cycle, and availability of alternative fuels.

While these considerations are used in normal times, the interviewee notes that they are currently purchasing trucks based primarily on availability. It normally takes six to seven weeks from the time the truck is purchased to the time they receive it, but during COVID, the truck shortage has caused delays of 8 months or more, so they are purchasing whatever trucks are available. The delayed truck deliveries are limiting their operations.

Fleet 12 has been largely shielded from the industry-wide driver shortage because they have their own driver-training school to teach new drivers how to operate at the ports and the basics of being a truck driver. They recruit people who recently received their Class A license. Fleet 12 purchases only new equipment with new technologies, which helps them recruit and maintain drivers.

Fleet 12 generally leases trucks for five or six years before returning them to the leasing company. The trucks they purchase are generally kept for six to seven years, and then sold to owner-operators, other fleets, auctions, and manufacturers. They generally avoid repowering trucks because they still have maintenance issues besides the power unit. While they generally keep a newer fleet, they have a few older trucks in the fleet because they are waiting on a grant they were awarded before they can replace the oldest trucks.

The central company has a goal of being an entirely zero emission fleet across all six companies. Their Southern California drayage operations are currently about 90% CNG. The interviewee noted that they can no longer full-service lease the CNG trucks, so they purchase them and contract with an outside vendor for service. All of Fleet 12's alternative fuel trucks are used in their Southern California drayage operations where they have refueling infrastructure available. They currently have FCEV, BEV, and CNG trucks, and are in the process of procuring more. They will have a total of 10 FCEV, four BEV, and six CNG trucks. They received financial assistance for the purchase of each of these trucks, whether through grants or funded demonstration projects. While demonstrating an electric truck, they found that the purchase price was too high given the limited range and long charging times, which did not meet the duty cycle they needed. However, drivers appreciated the vehicles because of the reduced vibration and new technology. Fleet 12 is very interested in FCEVs and believes that the technology is getting close to where it needs to be to deploy it more broadly. They do not have to make as many changes to their operations because it is so similar to diesel.

The fleet was pushed to try these alternative fuels because of the San Pedro' Bay Ports Clean Air Action Plan, which required them to switch to newer trucks and alternative fuels. Once the regulations were announced, they decided to get ahead of them and try the new vehicles before they were required. They have always had a company culture of being ahead in the industry and leading other fleets.

Interview Summary for Fleet Number: 13

1. **Region:** National and Canada
2. **Ownership Model:** Centrally owned
3. **Fleet size:** Over 1,500
4. **Truck type(s):** Class 8, straight trucks (Class 7)
5. **Use-case(s):** Short-haul, delivery
6. **Buy or Lease:** Purchase and lease (Mostly lease, some purchase (300 trucks, 1 division))
7. **Purchase condition:** New
8. **AFVs:** CNG, renewable diesel, Experimenting with electric

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Proactive
Complexity: Complex

<u>*Summary*</u>
The interviewee is the Senior Director of Transportation. Fleet 13 is a centrally-owned fleet that delivers products to convenience stores. The company has 30 distribution centers in the U.S. and 4 in Canada. Each distribution center has their own specific routes they service. The company also has over 100 regional and remote distribution centers. They have 1,500 trucks, mostly Class 8 with trailers divided into 3 compartments – freezer, cooler, dry. A small portion (200 trucks) are straight trucks used for deliveries in tighter quarters and don't require a Class A license.

The company has a team of decision-makers, but the interviewee leads truck acquisition for the company. He has a lot of authority to make fleet changes but seeks feedback from drivers and divisions, so they move new vehicles/technologies around the fleet and get feedback from users. They find that different divisions within the company seem to have a lot of autonomy for truck selection. Fleet homogeneity is not too important now because leasing companies (Ryder and Penske) take care of maintenance. The company primarily leases tractors (mostly full-service lease, but moving to finance lease), but purchases tractors in one of their divisions for flexibility. They used to full-service lease all trucks, but they are moving away from full service to finance leases because they want to be able to move the trucks between different distribution centers without being tied to a specific maintenance center. A few years ago, Fleet 13 acquired an Iowa company who purchases and services their own trucks (~300 additional tractors).

The company prioritizes fuel economy, which led them to want to negotiate new lease terms with Penske and Ryder, who wanted 7yr leases, but agreed to 5-6 years to accelerate cycle to get the most advanced truck (fuel economy, safety features, driver comfort, turning radius, etc.). They use a 3rd party to spec trucks and work with the leasing companies and OEMs for this because they always know what new technologies are available.

The driver shortage (which the interviewee believed started 15 years ago) influenced the fleet to emphasize driver satisfaction ("the truck is a driver's office"). They put drivers with sleepers (used mostly for tag team drivers) in hotels so they are rested and fresh—they also see them as an extension of the company. Regarding trucks, they primarily use Freightliner with Cummins engines (all automatic), to keep drivers happy but also be able to hire broadly, "today's truck drivers do not know how to drive manual”. They train all their drivers in-house. The Freightliner trucks were also selected because of their reliability, maneuverability, and safety features, which are better than other manufacturers. The company has a standard spec for their day cabs and a standard spec for the sleeper cabs so that their trucks are relatively similar across the different divisions. They are starting to accelerate the replacement cycle so that they can take advantage of increasing fuel economy and lower maintenance costs. When trucks operating in California fall out of compliance with CARB regulations, they are moved out of state and used in other divisions.

The interviewee considers their company to be “green”. They currently have 175 CNG trucks (50 in California). They started leasing CNG trucks in 2013 and paid for 5 refueling stations using grants for CNG leases. They started using CNG mostly for brand/public image as well as economics. But now CNG doesn’t make economic sense for the fleet because of maintenance, range, diesel prices, etc. They’re currently losing money on the CNG trucks and are moving away from CNG (the company couldn’t find a bank to support CNG in their applications; they can’t move CNG out of Florida because of a grant). They’re now using “renewable-diesel” in 60% of their trucks. They’re also demoing an electric truck tractor in Oakland and an electric drayage truck in Sacramento. They are testing 2 eTRUs in Bakersfield and will be adding 4 more thanks to a grant. The interviewee did a cost analysis on eTRUs and would be willing to pay more upfront if TCO comes out favorably. Third party does a TCO assessment. In-house they have a spreadsheet to make sure things “smell right” and they can compare leased vs purchased. They want to be the first to try out electric tractors even though the interviewee believes they will not be available for 2 years.

Interview Summary for Fleet Number: 14

1. **Region:** Regional- San Francisco Bay Area
2. **Ownership Model:** Municipal; Centrally owned
3. **Fleet size:** 660 trucks
4. **Truck type(s):** Class 2b-8
5. **Use-case(s):** Medium- and heavy-duty short-haul, Medium- and heavy-duty vocational
6. **Buy or Lease:** Purchased
7. **Purchase condition:** New
8. **AFVs:** Renewable diesel, CNG, ePTO, additional experience for LDV

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Mixed
Complexity: N/A

Inputs to decision-making: The company uses a *competitive bid* and is required to purchase the truck with the *lowest purchase price that meets their specifications*. Their first consideration is always *zero emission vehicles,* then *natural gas vehicles and other alternative fuels.* They target vehicles with the *lowest operating cost*, although they do not use a strict TCO calculation. They ensure vehicles are comfortable to maintain *driver satisfaction* and purchase from multiple manufacturers to avoid getting stuck with a manufacturer they have a poor relationship with.

How are they used: The fleet department purchased vehicles for other departments in the organization to use. Those departments report their needs to the interviewee in the fleet department who then selects and procures the vehicles that best meet these needs.

<u>*Summary*</u>
Fleet 14 is a municipal fleet with around 660 trucks. They have vehicles ranging from Class 1 to Class 8. The fleet department oversees purchasing vehicles for use in other departments. Public Works is the centralized department responsible for managing all fleets for the city (street sweeping, refuse, police etc.). Public Works has two main fleet yards, one which is leased from the Port of Oakland, as well as a police activity building. Public Works is "typically the decision maker," though they defer to the police department when decisions are being made about vehicles for the police department. Each department reports to the fleet division what their vehicle needs are and then the fleet department oversees selecting and procuring the vehicle that best meets those needs. The interviewee describes the relationship between the "customer units" (other departments) and Public Works as working together, "customer units identify where they need vehicles parked and when they need to be available for drivers based on shifts."

As a municipal fleet, they are required to purchase the vehicle with the lowest price that meets their specifications, which is done through a public auction. They can also piggyback off other municipal fleet bids.

For every vehicle purchase, Fleet 14's first consideration is whether they can purchase a zero-emission vehicle (battery electric or fuel cell). If they cannot purchase a zero-emission vehicle, they move on to the second choice option of natural gas. If no natural gas vehicles meet their specification, they look at a plug-in hybrid, and finally renewable diesel if no other option works. This scheme was developed due to city mandates that require the fleet to reduce their carbon emissions below a certain level. The fleet is currently using natural gas and some renewable diesel street sweepers.

It is also important for the fleet to select vehicles with the lowest upfront and operating costs because they have a budget deficit and there is never enough funding to cover all the vehicles they need to replace. While they do not explicitly consider TCO in their purchase decisions, they do check the cost savings from fuel and the resale value. They do not translate this into a full TCO calculation because it can be difficult to know exactly how the TCO will work out and because the funding for the vehicle's purchase and its operations come from different places, so no single department sees the overall savings. These cost constraints lead Fleet 14 to take advantage of grant and incentive opportunities for low and zero emission vehicles wherever they can before the funding opportunities close.

An additional consideration in the fleet's purchase decisions is trying to ensure vehicles are purchased from multiple brands and dealerships so they do not get stuck with someone they have a poor relationship with. Finally, the interviewee discussed the importance of driver opinions on their purchases. They mentioned that labor markets are so competitive they need to provide drivers with a vehicle with which they are comfortable to retain them.

The choice to retire the fleet's trucks is based on how much money they are allocated to replace vehicles each year. All vehicles in the fleet are ranked from most to least in need of replacement and the funds are allocated to replace vehicles in order. All retired vehicles are sent to public auction, which is required of most government fleets.

Interview Summary for Fleet Number: 15

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 700
4. **Truck type(s):** Classes 2b, 3, 4, 7, 8 (cryogenic)
5. **Use-case(s):** Long-haul, short haul, vocational
6. **Buy or Lease:** Purchase and Lease
7. **Purchase condition:** New
8. **AFVs:** CNG and LNG, interested in hydrogen

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: *Safety* is the top purchase criteria, followed by *cost*. *Driver comfort* is also a large part of their purchasing criteria. The winning bid accounts for meeting the specs, *truck reliability,* and ability to *meet delivery schedules*.

How are they used: Trucks are purchased through a bid process twice per year.

<u>*Summary*</u>
Fleet 15 is a dedicated fleet fulfilling the transportation needs of Company 15 which produces industrial liquids and gasses. Transporting the products requires specialized cryogenic trailers designed to keep the products in sub-zero temperatures. The interviewee works within a group composed of fleet operations, asset management, engineering, and in-house maintenance, where his role is to optimize fleet management. Fleet 15 has a central set of employee drivers (≈750) and a subset of contractor drivers (≈100) that they employ seasonally when demand is high.

All their trucks are purchased through a formal bid process which they hold twice per year. The bid process involves creating a spec and soliciting bids from five or six different manufacturers. One of the main focuses of their specification is safety, which the interviewee notes comes before cost and profits. To ensure they have the safest equipment, Fleet 15 often tests new safety features for companies by deploying them within a subset of drivers for 4-8 months, and then repeating testing in a different subset for the same time frame. Once they feel a particular technology is proven, it is added to their spec and deployed fleetwide. Fleet 15 has even given manufacturers ideas for safety features (e.g., orange seat belts) which have been deployed across the industry. Beyond safety enhancements, their specs also include certain weight, height, and length requirements, as well as driver comfort features. Fleet 15 selects the winning bid based on which manufacturer can produce the specified truck, as well as reliability and availability (e.g., delivery schedule). Once a manufacturer is selected, the sourcing team works with the manufacturer through procurement.

Due to the specialized nature of their product, Fleet 15's drivers are required to have tank and hazmat certifications with training updates every four years, and complete internal company training every 6 months. The interviewee notes that one of their biggest challenges is maintaining their relationship with the drivers, who they see as investments considering most drivers are generally not trained in working with their specialized equipment and products at time of hire. In addition, the interviewee notes that getting new drivers can be challenging because of the perception that it's a dangerous driving job. To combat both issues, Fleet 15 offers generous pay, benefits, and recruiting bonuses in addition to regular schedules where the drivers work the same shifts each week. While newer drivers are given shifts on nights and weekends, drivers who have been with the company longer are offered weekday working hour shifts. The results have been a low (for the industry) turnover rate.

Unlike general trucking equipment, cryogenic trailers are very expensive (generally close to $300,000, sometimes up to $1.5 million). Although there is the ability to pass on the cost of new trucks/technology onto the customer, Fleet 15 still tries to replace their trailers based on the lowest TCO. In their TCO, they calculate the purchase price against the increased maintenance costs (preventative maintenance, accident costs, and unexpected maintenance), the cost to replace the trailer, efficiency, and weight. Given that the equipment is so specialized, they cannot use commercially available TCO models, and need to modify them to meet their needs. Based on these models, they keep the cryogenic trailers for 40 years, refurbishing and recertifying them every 10 years. Refurbishment costs about $150,000, which is not in the TCO models. Fleet 15 doesn't believe that replacing the trailers on such a long-time frame is an issue because the technology changes so slowly. The high costs of the cryogenic trailers also lead to competitor concerns, and to avoid this, Fleet 15 scraps the trailers when they are done using them. On rare occasions they have sold a trailer to another fleet, but with an agreement that they can only move products from Company 15.

Fleet 15's replacement cycle for tractors is much quicker (4-6 years). Tractors are also replaced using TCO calculations, which vary based on use case and how fast the technology is improving. If weight (one of their largest concerns), safety, or efficiency have improved significantly, or maintenance costs are especially high, Fleet 15 will replace tractors ahead of schedule. Trucks are resold through an external remarketer.

Fleet 15 operates 10 CNG trucks and 5-10 LNG trucks in California and Texas. While the fuel economy on them is not as good as diesel, they decided to purchase them because they had infrastructure in place and received grants to offset some of the purchase. Fleet 15 isn't currently operating any hydrogen fuel cell trucks, however, Company 15 manufactures hydrogen fuels, so they are hoping to transition some trucks to hydrogen in the next 5-10 years and want to encourage other fleets to transition as well. Fleet 15 is currently in negotiations with a few manufacturers to try to demonstrate hydrogen trucks. They believe that the largest industry-wide barriers to adoption of hydrogen fuel cell trucks are that people are unfamiliar with them and often associate hydrogen with bombs. It will be important to ensure that the power, range, weight, and cost are able to meet their needs before they will be willing to incorporate them. The fleet has not tried electric trucks, they don't believe it would work for them, and are largely uninterested in them since they are a hydrogen company. They believe that the increased weight and the unfamiliarity of their maintenance team with working on them would pose issues.

Interview Summary for Fleet Number: 16

1. **Region:** Los Angeles and Long Beach Ports
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 50 tractors and several ISO tanks/chassis
4. **Truck type(s):** Class 8
5. **Use-case(s):** Drayage, short haul
6. **Buy or Lease:** Buy
7. **Purchase condition:** New
8. **AFVs:** Ordered 18 natural gas with grant funds and demoed electric trucks

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: *Experience with brand, maintenance costs, fuel economy, inspection compliance, and regulatory requirements.*

How inputs are used: Fleet 16 has eliminated problematic models from their operations. Trucks are sold based on maintenance cost projections, reduced fuel economy, and the probability of receiving highway inspection infractions. Grant eligibility, port fees, and state regulatory mandates are also significant purchase determinants.

<u>*Summary*</u>
Fleet 16 is a drayage company operating out of the ports of Los Angeles and Long Beach and nearby intermodal rail yards. Their business focus is consumer goods and special commodity chemicals. They own a lot of ISO tankers (for hazardous and non-hazardous liquids) and specialize in transporting chemicals to surrounding southern California communities and the Inland Empire (which includes the cities of Commerce, Vernon, Long Beach, and Carson). Fleet 16 owns and operates 50 tractors, and all drivers are employees (not 1099s). They must buy special chassis for ISO tanks (lower center of gravity and wider base) which are expensive and last about 20 yrs. The port-ready tractors are purchased new and last about 10 years ("unless California forces me to change them"). Fleet 16 prefers Volvo and Freightliner because of the better gas mileage, low maintenance costs, and in-house maintenance familiarity.

They have not purchased any new tractors for three years because of the forthcoming CAAP 2.0 revision (Clean Air Action Plan for both ports). Fleet 16 anticipates they will need to buy near-zero emission trucks, so they have been applying for Carl Moyer Program and 1B grants. They ordered 18 CNG trucks (must be delivered by the end of year for grant eligibility) in effort to avoid the $20 port entry fee. CNG, and other alternative fuel trucks are exempt from this fee, which is otherwise charged every time a truck enters the port.

Fleet 16 has a very aggressive driver recruitment training program. Fleet 16 is self-insured b/c insurance companies would not allow them to hire anyone under 23 years of age. They recruit and train younger drivers before they earn enough to buy their own trucks. Also, they do not hire 1099s: all drivers are employees for insurance reasons. Ports and rail yards are challenging environments (especially for inexperienced drivers) because of the fast pace and tight quarters, so they buy new but not fancy trucks (most trucks have dents/paint marks on bumpers).

Primary purchase determinants are maintenance costs, fuel economy, and forthcoming regulations. Fleet 16 tried other manufacturers, such as International with Duramax, but had issues. Now they prefer Volvo and Freightliner with DDC engines. A third-party company tracks operating and maintenance costs.

Fleet 16 changed their operation because of COVID. Drivers were switched from working 5 eight-hour days to 4 ten-hour days per week. They also stopped "hot seating" (where a driver immediately takes over a truck from the previous shift driver). This change was made because drivers didn't want to share trucks because of COVID. To accommodate the extra truck need, Fleet 16 rented 13 trucks for 2020, so drivers could avoid sharing cab space. After 1 year, they returned the rentals and fixed up some of the older trucks they owned to give to their newest drivers. They never went back to hot seating.

Fleet 16 sells trucks after they are retired from service. They put their used assets in a company-owned lot with a "for sale" sign. They believe this method provides the best profit and avoids under-valuing their trucks in an often-unpredictable used-truck market. They often sell to sanitation companies because retired port trucks with relatively low mileage make good trash haulers. Service life depends on maintenance costs and the strategic avoidance of truck inspection penalties. Regular inspections are conducted by the U.S. government and the state of California. In addition to the penalties assessed for even minor mechanical infractions, the violations also negatively affect a company's Compliance Safety Accountability [CSA] score which has long-term cost consequences.

Fleet 16 claims to be supportive of laws requiring cleaner trucks and the interviewee believes that large profitable corporations should lead the way. He feels that clean air is a worthy goal. On the other hand, they do not plan to take any initiative to incorporate cleaner trucks without mandates or financial incentives. "Without a regulation, we're going to continue to operate our diesel tractors".

Interview Summary for Fleet Number: 17

1. **Region:** Oakland Port and region short haul, reactive (negative)
2. **Ownership Model:** Driver-owner (7 trucks/drivers) and company-owned (10 trucks)
3. **Fleet size:** 17 trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Drayage, short haul
6. **Buy or Lease:** Purchased and leased
7. **Purchase condition:** Purchased 5 used/ leased 5 new
8. **AFVs:** Natural gas and electric trucks

Keywords
Decision Making Structure: Egalitarian
Adaptability: Mixed
Complexity: Simple

Summary
Fleet 17 is a small, family owned (2 families, 4 owners), drayage company operating out of the Port of Oakland. The company's decision-making process involves two owners (father and son) making purchase decisions, although all 4 owners must sign off on the final decision. The fleet composition - driver-owner vs. company-owned, leased vs. purchased, and total vehicles – has changed over the last few years because of business fluctuations and unforeseen incidents. The company has responded quickly and made appropriate fleet adjustments. The fleet is essentially the business (opposed to serving the business)

One of the primary expressed determinants for near-term truck purchases (and retirement) is forthcoming CARB regulations (2035) and even more restrictive and closer (2023) Oakland Port mandates that require all new trucks registered at the port to be zero emissions. These regulatory changes will result in a significant departure from business as usual. They must retire owned trucks prematurely to purchase cleaner (but not zero-emission) trucks before 2023. These trucks can then operate for 8 years or 800,000 miles in lieu of zero emission trucks. Response to the regulations is reactive and a minimal level of compliance because of high upfront cost. Fleet 17 does not do any type of detailed cost analysis or tracking. Truck retirement determinations are based on maintenance costs or lease terms.

Fleet 17's main compliance concern is cost. Although they are pursuing every grant possible, the grants still only cover about half the purchase price of an electric truck. This means the company still must pay about $250K per electric truck. This is much more than they pay for used diesel trucks. The upfront cost differential is viewed as prohibitive. Fleet 17 operates like many drayage companies that purchase used vehicles (port drayage companies have historically purchased the oldest used trucks available – it's "where trucks go before, they die"). They run them into the ground and then try to sell them to the final owners for low-use applications (e.g., farmers). They are worth very little at the end of their port life. Fleet 17 relies on a network of fleets for used vehicle purchases because it is important to know the vehicle history (more important than warranties). They did start leasing additional trucks a few years back due to an influx of work that coincided with the departure of several owner-drivers. The company continues leasing today, even though the workload has subsided. While purchased trucks are used, leased trucks are new. They are also considering acquiring rental trucks to meet demand. Another consideration is the driver shortage, which is especially pronounced at ports because drivers require special skills (e.g., maneuvering in tight quarters) and they must be willing to deal with long queues. The interviewee reports older drivers prefer to keep trucks they are used to, so newer trucks and technologies go to less-experienced, younger drivers.

Interview Summary for Fleet Number: 18

1. **Region:** Southern California
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 1,500 trucks
4. **Truck type(s):** Class 2b-8
5. **Use-case(s):** Municipal, medium- and heavy-duty vocational
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New
8. **AFVs:** Natural gas and electric trucks

<u>*Keywords*</u>
Decision Making Structure: Hierarchical, egalitarian
Adaptability: Mixed
Complexity: N/A

<u>*Summary*</u>
Fleet 18 is a municipal fleet with around 1,500 trucks. Truck purchases are made by a central fleet department that includes both acquisitions and maintenance sub-departments. The manager of both deals with routine matters but the central fleet manager gets involved when they set new purchasing policies or change something significantly. Fleet decisions are made by the central fleet manager, the person in charge of acquisitions, and two other managers in the fleet department.

The fleet's primary decision factor for truck purchases is meeting the regulations. They operate in Southern California so face many regulations from the state and the regional Air Quality Management District to purchase alternative fuel vehicles. The fleet is also constrained in their purchases by the city council, who wants to be as green as possible. If they have the funds to purchase cleaner vehicles, they will do so.

To fund the vehicles, they charge the departments a monthly fee so they can replace the vehicles when one is retired. They additionally save supplemental funds to acquire new technologies and alternative fuel vehicles. The interviewee makes decisions whether to purchase alternative fuel vehicles based on whether they can justify spending more on them. They feel it can be hard to keep up with all the regulations, but as a large fleet, they have enough staff and analysts to support them and stay ahead of the regulations.

Their purchases are done through a bid system or a cooperative purchase agreement, depending on which best supports their needs. If the vehicle they need is already on a pre-existing contract, they will purchase based on that contract, otherwise they will create a new bid request. They create replacement cycles for different classes of vehicles based on the intersection of purchase price, operating costs, and resale value. These cycles are created based on the decision-maker experience rather than cost calculations. These replacement cycles are updated every 2-3 years and when a new technology is added into the fleet. The vehicles are sent out to bid when they are done with them.

Interview Summary for Fleet Number: 19

1. **Region:** Southern California (headquartered)
2. **Ownership Model:** Owner-operator
3. **Fleet size:** 40 trucks
4. **Truck type(s):** Medium- and Heavy- Duty box trucks, Class 8 tractors, a few delivery vans
5. **Use-case(s):** Local delivery, drayage
6. **Buy or Lease:** Purchase
7. **Purchase Condition:** Used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

<u>*Summary*</u>
Fleet 19 is a single-owner local delivery service in Southern California that also does drayage out of the Port of Los Angeles. The fleet consists of 40 used vehicles, mostly Medium- to heavy-duty box trucks. They also own and operate about 18 Class 8 tractor trucks and a few delivery vans. Their decision-making process is autocratic with the owner making all purchase/retirement/disposal decisions. History, judgment, and "common sense" are the primary decision factors used in lieu of any cost tracking or data-based assessments.

The interviewee uses a broker to help find used trucks on the market but recently leased a vehicle as an "experiment" to determine cost and viability. Revenues are up 30%, so they will be expanding the fleet. Electric trucks were investigated in the past but rejected because they didn't have lift gates. The company has never investigated grant opportunities for new truck technologies. The interviewee considers their Hino trucks to be "hybrids" because of piston disengagement at idle (they received a rebate on the trucks). The fleet is essentially the business (opposed to serving the business).

CARB regulations are the biggest purchase determinants currently. Several of their trucks will soon be "CARBed out". They are only informed of this when they are no longer allowed to register their trucks at the DMV. Truck retirement is based on a maintenance cost feel. When maintenance costs become exorbitant, they 1) sell if they think they "can get money for it" or 2) cannibalize it for parts and take it to the junkyard. Driver input is not considered for truck purchases. The interviewee feels that CARB is doing okay, regulations are a little "prohibitive", but "it is what it is". He doesn't get stressed out by it.

Interview Summary for Fleet Number: 21

1. **Region:** Northern California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 890 vehicles (including, but not entirely trucks)
4. **Truck type(s):** Classes 1-8
5. **Use-case(s):** Municipal: short-haul, local delivery, heavy vocational, Medium-vocational
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:**

<u>Keywords</u>
Decision Making Structure: Egalitarian, hierarchical
Adaptability: Mixed
Complexity: N/A

<u>Summary</u>
Fleet 21 is a municipal fleet in Northern California with roughly 35 different departments, each with different divisions. Their fleet is composed of everything from pick-up trucks and vans (cargo, passenger, and work) to dump trucks, prisoner transport buses, law enforcement vehicles including armored tactical vehicles for the Sheriff, and reefer and box trucks. They also have on-road construction equipment.

The interviewee oversees "the whole procurement process," although the purchasing department "actually issues PO [purchase orders] and does the transaction." The main players involved in the decision making are the interviewee, another spec writer (equipment supervisor), the Division Chief (the interviewees boss), the Light Fleet Manager and/or Heavy Fleet Manager, and the user departments. The interviewee's responsibilities include writing all the specs, working with all departments to plan acquisitions, researching how equipment is working, and researching changes to equipment. He works with industry manufacturers and body builders to build the "best spec that meets our needs, that's best value to the county," and then puts those specs out to bid or uses co-ops. It's not unusual for them to piggyback on another bid. Once the bids come back, the interviewee evaluates them and makes decisions with the "customer" (a.k.a. department) about which bid would best meet their needs which he tells purchasing. He then manages the "actual build", characterizing each as a project within themselves. He notes that the customers do have a bit of influence, however, their perspectives tend to be more focused on their own needs and they aren't always aware of the latest equipment. The fleet will sometimes treat their vehicle purchase decisions as they would a personal vehicle instead of a fleet vehicle. In those cases, the interviewee says he acts as sort of a "control", focusing on buying the vehicles that suits the purpose and is efficient. He says, "sometimes we have to force our hand a little bit." If a customer demands a vehicle different from the one interviewee endorses, the customer must pay additional rental rates. He said, "sometimes it's a compromise, but it's a negotiation each time."

The most important factor influencing vehicle acquisition is "overall value," which he says depends on the vehicle you're purchasing. Some factors he places within overall value are "the skillset of technicians, current fleet makeup, historical vehicle reliability," They track TCO "to a high degree and use that to enter valuations." To monitor TCO they use fleet management M5 Assetworks, where they can run total cost of ownership to a very detailed level. He says that a challenge is that "as fast as technology and vehicles change, your TCO for the vehicle you've had for 8-10 years may change drastically when you buy a new model."

During the bid evaluation, they go to great lengths to be brand agnostic and take in bids from anyone who submits. In purchasing, they try to buy equipment that is consistent with the current fleet makeup so that it can be easily entered into the fleet system and maintained (i.e., the trucks aren't foreign to them and don't require them to stock additional parts). This is important because most of the maintenance occurs in-house per agreement with the maintenance union. Despite this restriction, the interviewee says, "we don't want to hinder anybody from being able to bid, we don't put out predatory specs so that only one or a few bidders can bid. We open it up to the world– let everyone bid and have an opportunity. If the new thing fits and overall it's the best value to the county, we will go that direction. If it does a good job, we will put the odd vehicle in our fleet, but there's a lot of factors that go into it."

Regarding retirement, the interviewee says he is constantly tuning up the replacement forecasting process. He noted that a fleet can have a replacement schedule relying on miles or time, or both, but the budget, availability, and lead time to buy equipment must meet up with the replacement cycle. He tries to plan ahead to have replacement vehicles coming ahead of their retirement deadline, but the budget doesn't always allow for that. He says it's a "constant moving target" which requires constant discussions between the two fleet managers, the interviewee, and his supervisor (Division Chief). Typically, a fleet manager makes a recommendation, and then he starts the purchase process.

Light duty vehicles typically get 10 years or 120,000 miles, although some trucks are 13 years old and haven't hit 120K miles, so they are kept "until it makes sense, till the costs go up". Heavy equipment is generally given a 10-year replacement cycle. The refuse trucks operated by the Department of Waste Management have a planned 7-year cycle, but vehicles regularly go 10-12 years. The fleet's overall motto is, "once maintenance costs go up, we replace it." When they're retired, trucks go to the surplus property and are sold by open bidon publicpurchase.com, a bidding site that caters to municipalities and public agencies. It is very seldom they cannot sell a truck, but if it ultimately happened, he's sure they would scrap it.

Regarding AFVs, the fleet adopted their climate action plan in 1999 which encouraged them to purchase alternative fuel vehicles and heavy equipment. This led to the Department of Waste Management operating all natural gas trucks. And then within the department they've set additional clean air goals. The goal is 75% of the rental pool to be AFV or zero-emissions electric vehicles by 2025. They're already over 60%. The county just came out with a new climate action plan, and CARB's advanced clean truck policy "will probably put us on a more aggressive track." They aim to synchronize their goals with CARBs requirements.

Interview Summary for Fleet Number: 22

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 35,000
4. **Truck type(s):** Class 2b-8
5. **Use-case(s):** Long-haul, Short-haul, Medium- delivery
6. **Buy or Lease:** Purchase and Lease
7. **Purchase condition:** New
8. **AFVs:** Electric, CNG, LNG, HEV, ePTO

Keywords
Decision Making Structure: Hierarchical, egalitarian, siloed
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: Their truck purchase decisions are generally made based on *past procurements* whereby a history of poor experience with a manufacturer will lead to the fleet avoiding their brand. *Truck performance* and ensuring that it can meet the needs of the organization is the most important factor. *Driver satisfaction* is an important component because it helps recruit and retain drivers, which can be difficult. P*urchase price and detailed TCO* are both accounted for in the initial purchase decision.

How are they used: The interviewee works with the procurement and technology departments to develop specs. Truck performance is the most important criterion, which includes past procurements.

Summary
Fleet 22 is a large, hierarchical company. They generally purchase most of their trucks, but lease some of them when economic conditions limit their cash flow. The interviewee works in the central fleet department, which has distinct technical, procurement, and retirement groups that report to him. He works directly with the company's technical group to write specs for the vehicle and then the procurement group goes out and makes the purchase. Both the procurement and technical groups need to agree on the purchasing criteria, which they generally do. The company also has its own maintenance team that services about 80% of their vehicles, however, in more rural areas, they work with the local shops or dealers to maintain trucks.

Their truck purchase decisions are generally made based on past procurements, purchase price, TCO, and performance. If the fleet previously had a poor experience with the manufacturer, they would avoid working with them for future purchases. The interviewee notes that their TCO calculations are very detailed and are performed by a team within the organization. While he does try to keep the trucks slightly standardized to help reduce maintenance burdens, this is not a large factor in their decision-making. Other factors are much more important. The most important determinant in truck purchasing is making sure that the truck can run the routes it needs to run. The interviewee notes that it is operationally better for them to choose the trucks that best meet the duty cycle of the routes rather than keeping all the trucks the same ("right vehicle, right route”). This helps them reduce emissions because the routes are not designed equally, so the trucks can be optimized to their routes.

The interviewee notes that driver satisfaction is a large component of their heavy-duty truck purchasing. This is because the heavy-duty trucks need a special driver’s license, so fewer people are eligible and hiring is more competitive. The fleets tend to get into “bidding wars” over the drivers with different fleets offering additional bonuses and benefits to help recruit and keep drivers. They also work to keep their vehicles newer to help recruit. The driver shortage has become even more of an issue in recent years because the driver schools were shut down during COVID, limiting the supply of new drivers.

Previously, all their trucks used to be crushed at the end of life, but they have since switched to reselling them at auctions. They begin retiring trucks when the maintenance costs reach an inflection point where the increase in price is disproportionate to that of their mileage. This calculation is a function of the truck’s age, maintenance costs, and mileage, which are used to minimize the risk of increased costs towards the end of the truck’s life. Additionally, if the truck requires any major repairs, then they just retire it because they don’t want to deal with the high costs.

The replacement cycle is increased for alternative fuel trucks to help account for the increased uncertainty about how long they will last and the smaller market for used alternative fuel trucks. Fleet 22 is operating CNG, LNG, ePTO, PHEV, and BEV trucks across their vehicle classes. Most of their electric trucks are Class 8 delivery trucks, which they try to incorporate where possible. Over 90% of their electric trucks are running on routes that are 140 miles or less per day. They are currently operating over 35 electric trucks in California and are in the process of incorporating more. They decided to try electric trucks to meet their company’s unofficial emissions reduction goals, as well as pressure from leadership and customers. The fleet is allocated a certain amount of money each year for them to try new fuels and technologies, which helps lessen the financial burden of the transition.

Interview Summary for Fleet Number: 23

1. **Region:** North America (U.S. & Canada)
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 25 trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Short-haul
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

<u>*Summary*</u>
Fleet 23 has been in business for 17 years. It started off as a Canadian based intermodal marketing company but has now expanded into the US. Fleet 23 offers "intermodal and highway services," but also uses "rail assets." They own their own trucking operations in the U.S. and in Canada where they use Class 8 trucks to provide final mile deliveries and pickups. They have a total of 25 trucks in their fleet with three hubs– one in Chicago that delivers to Wisconsin, Minnesota, Western Michigan, Ohio, and Indiana, another in Los Angeles which delivers up and down California, and one in Canada that delivers locally within Montreal.

When purchasing trucks for their fleets, the company are self-described, "primarily brand-loyal." The interviewee noted that they've "switched from one brand to the other a couple of times," but that when they "find a brand that's provided reliability and a fair price… we tend to stick to that." He explained a "fair price" doesn't necessarily mean the cheapest, just having the quality of the truck on par with the upfront cost. He explained their motivation in sticking to one brand is "because it's a lot easier in managing your fleet in two different countries when you've got the same model, the same dealerships that you're dealing with, and if you get stuck anywhere from interstate or interprovincial, it's a lot easier to get service and maintain." He said they stick with a particular brand unless "all hell breaks loose."

Fleet 23 started off with Freightliner until they experienced "quality issues," and felt that Freightliner "didn't come to the table with what we thought was proper to remedy [the situation]." They switched to International but experienced issues related to "changes of motors, engines, and anti-pollution devices that were breaking down and it was costing a fortune to change." They currently use Kenworth and have been doing so for the last 6-7 years. They value their relationships with Kenworth regional dealers and are not interested in other brands. He also described the impact of fleet size on being brand loyal, citing having a larger fleet makes you more apt to stay put, because it's difficult to transition an entire larger fleet to a new brand. "As long as we're happy, there's no need to revisit one supplier to the other because, the biggest fear is, as you get bigger and as you add more trucks, and the way that we've built our business model, sticking to one brand, making it very simple, is when you do decide to make a change, it gets more and more difficult as you continue to grow. So um, you kinda gotta pick your poison, hopefully it's the best one. If we do make the move to go to another supplier, it's not going to happen in, in you know, five hours, we're not going to change the whole fleet, it's just, as the new fleet comes in, you start committing and that may take, you know, two-three years to make the whole switch over. If we had a bad experience and we don't want to do business with Kenworth or anybody else anymore, we want to change, it's still going to take us a good, you know, few years to make that transition,"

Fleet 23 both purchases and leases new trucks, depending on which has more "incentive." "Corporate" makes that decision, purchases/leases are made on a yearly basis. When making purchases, the interviewee also cited looking at "total cost," which they described as "the cost of the equipment" as well as what equipment can get "quality drivers," citing "it doesn't matter how expensive or how inexpensive that truck is, if you don't have a driver, it's worthless." Driver satisfaction was a huge driving factor for Fleet 23 who ultimately feels like quality equipment and quality drivers are the keys to success. "If you've got the good equipment, if you've got reliability on that equipment and things that make sense, then you know, you get to retain your drivers and at the end of the day that's, that's the combination that makes you successful." To appeal to drivers, Fleet 23 only purchases or leases new trucks and they don't "circus" drivers. As they put it "if you work for us, that truck is assigned to you and that truck is yours until we get you a new one." Their drivers like trucks that are reliable (don't break down frequently), comfortable, and have automatic transmissions.

The fleet is also impacted somewhat by external mandates and regulations. They said they mostly rely on the manufacturers to sell them the right equipment that "conforms to California standards." They also deliver and pick up at railyards and ports (they don't operate drayage), so they are subject to those regulations. Regarding port mandates, the interviewee explained, "we're really not in a position to dictate, it's really dictated to us what we're required to continue to operate." They cited buying/leasing only new trucks as protective/a proactive way to deal with regulations and mandates. "If you're turning over a modern fleet, you don't have to really be concerned about regulations as far as emissions and alternative fuels and everything because the manufacturers are going to be on top of it."

They also cited having a relatively short life-cycle (5-6 years) as protective, citing "when you're buying new equipment, usually that new equipment is pretty recent, and if emissions or things are going to change, you bought a new equipment, you're more than, you got more runway than you think beyond five years so, in our cycle of five or six years, the runway is fine for us." In addition, the fleet typically has a 5-year bumper to bumper warranty on the trucks they purchase. When retiring trucks, they either trade them in or sell them into the secondary market. They typically get good value, which the interviewee attributes to keeping trucks in such great condition due to warranty.

The fleet does not currently have any AFV trucks and are hesitant to try any. They cited obstacles including limited choices/availability of trucks, range uncertainty, and limited fueling options. They feel they have environmentally friendly practices because they only do final miles for pick up and deliveries but primarily rely on rail, which is better than long-haul trucking for the environment.

Interview Summary for Fleet Number: 24

1. **Region:** Los Angeles and Long Beach
2. **Ownership Model:** Driver-owner
3. **Fleet size:** 22 trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Port drayage, regional short haul
6. **Buy or Lease:** Lease
7. **Purchase condition:** Used
8. **AFVs:** 2 CNG

Keywords
Decision Making Structure: N/A
Adaptability: Reactive
Complexity: N/A

Inputs to decision-making: Fleet 24 contracts with drivers who bring their own trucks. Fleet 24 then leases those trucks from the drivers. This arrangement is primarily for insurance reasons. Fleet 24 is indiscriminate regarding the make, model, and age of trucks that they lease.

How are they used: The bar for drivers and trucks is very low. Drivers must undergo a minimal background check and the truck must pass a basic inspection.

Summary
Fleet 24 does not purchase or dispose of vehicles but, rather, they hire owner operators that bring their own trucks. Fleet 24 leases used trucks from owner-operators (a lessor may have multiple trucks). All drivers are 1099 workers. Currently Fleet 24 is leasing 22 trucks from drivers but will soon get about 8 more because of increasing business. Fleet 24 does own 10 chassis. Fleet 24 recruits owner-operators via social media, including Facebook and Craigslist, and word of mouth (they have a big network from being in the business for 20 years).

All lessors sign the same lease agreement and drivers must undergo license and background checks, drug testing, and a truck inspection. Fleet 24 pays a company to conduct these tasks and, if greenlighted, Fleet 24 must get approval from their insurance company to hire the driver and lease his/her truck.

There is an ongoing problem of getting enough 1099 drivers (and their trucks) on the day they are needed. This is due, in large part. to the pandemic, The drivers are self-employed and don't always want to work when needed. So, of the 22 drivers the contract with, they may get hire only 1 or 2 per day, "if they show up". This drastically affects their business. Fleet 24 only has 7 clients but always has more work than drivers. Prior to the pandemic, Fleet 24 claims they did not experience a driver shortage problem because the owner is well-networked and drivers like contracting with him.

They anticipate a driver shortage when ports ban trucks older than 2018 (the current age limit is 2014 model year trucks). Owner-operators can only afford older trucks and 2/3rds of his drivers say they will pursue other careers rather than purchase a newer truck (although, they said the same the last time the ports restricted truck access). The interviewee expects that the truck ban will significantly raise rates across the drayage business. The cost of the new trucks will be passed on to all those involved with moving freight.

Fleet 24 did lease two natural gas trucks once, but they performed poorly (no power). Therefore, they were limited to just hauling chassis and empties with those two trucks. Fleet 24 managed to accommodate those two natural gas trucks and they feel they could do the same for electric trucks. The interviewee confidently proclaimed, “if they can haul loads, we’ll hire them.”

Interview Summary for Fleet Number: 25

1. **Region:** Southern California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 350 Trucks
4. **Truck type(s):** Classes 2b-8
5. **Use-case(s):** Short-haul, local delivery, heavy vocational, Medium- vocational
6. **Buy or Lease:** Purchase and Lease
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Egalitarian, hierarchical
Adaptability: Mixed
Complexity: Simple

Inputs to decision-making: Most of the company's vehicles are provided through a deal with manufacturers they have *networks and relationships* with. He works with the customers to incorporate *driver input*. They have *sustainability goals* that will influence their purchases towards alternative fuel in the future, but these goals are not yet affecting their decisions.

How are they used: The interviewee works with the customers, maintenance team, and environmental team to create specs, which are approved by the finance team. Bids are sent to preferred vendors. The maintenance team helps decide which vehicles to replace each year, which then needs to be approved by the company leadership.

<u>*Summary*</u>
Fleet 25 is a dedicated fleet serving the needs of Company 25. The interviewee is newer to the industry and has been with the company for 2.5 years. His role includes procuring vehicles, understanding the specs, and making modifications based on customer (departments within Company 25) needs. He coordinates with the customers, maintenance team, and environmental team to develop the specs and then sends them to the finance team to approve funding for them. Once financing is approved, he works with the dealers to procure them. Fleet management makes up only 35-40% of the interviewee's job, while responsibilities outside of fleet make up the majority.

Of the 90 vehicles Fleet 25 leases, they only pay for 8 through a traditional lease system. The remainder of the vehicles are "leased" through a "special deal" with one of their partner companies who allows them to lease the vehicles for two years in exchange for advertisements through Company 25. After the two-year leases expire, the vehicles are replaced with new ones. During the leases, Fleet 25 is responsible for paying for the damages to the vehicle, but not monthly lease payments. The interviewee was not certain how the specifics of the agreement work since they were developed before he came to the company.

To determine where to purchase vehicles from, the interviewee scores and ranks each vendor they work with annually based on factors such as communication, order completion, and the competitiveness of their quotes. After they are ranked, they choose a certain number of "preferred vendors" and the scores are sent out to each vendor so they know where they stand and how to improve. This process allows Fleet 25 to develop relationships with the dealers and helps keep them competitive since they aren't bound to any long-term purchase agreements. Bid requests are then sent to their preferred vendors. This scoring method was developed by the previous fleet manager who worked with a consulting group to create lifecycle costs for the trucks which are used for evaluation (7-14 year life cycles). The interviewee has not changed the preferred vendors or scoring criteria since the previous fleet manager.

Generally, there are around 25 vehicles that need to be replaced each year. The interviewee works with the maintenance team to decide which trucks should be replaced based on which ones have the most maintenance issues. He then develops the budget needed to make these replacements and sends it to the finance team who must get it approved by the vice president of the company. Fleet 25 usually receives the same annual budget for replacements but will occasionally receive extra funds if requested. While awaiting budget approval, the interviewee works with the customer who will be operating the vehicle to confirm whether they want the same specs as the previous vehicle, which is generally the case. Once he has confirmed the funding and spec, he sends them to Fleet 25's preferred vendors to get quotes. Fulfilling specs is typically simple due to previous purchase history with preferred vendors. Specs often include safety features like backup alarms, cameras, and sensors.

Occasionally a customer will ask to replace their trucks ahead of schedule, at which point the interviewee will work with the maintenance team to review the last four years of the vehicle's maintenance history and the estimated cost to keep it for the next six years (labor hours, potential safety risks, and parts costs). If he finds that the vehicle needs to be replaced (costs to keep it outweigh costs to replace), they move up the replacement cycle. The interviewee is the sole decision-maker regarding replacing vehicles early, although he works with technicians to make his conclusion. In addition, his decision needs to be signed off by the maintenance manager, the director, and the property control manager. The property control manager is then responsible for taking the vehicle to an auction house for sale.

Company 25 is very interested in portraying a green image, however, many of their trucks are operating out of the public eye, so customers are more interested in the vehicles they can see, making customer facing vehicles more likely to be AFVs. Historically Company 25 has been less focused on converting Fleet 25 behind-the-scenes trucks involved in their day-to-day operations. Currently, the fleet includes 3-4 CNG trucks, which are mixed in with their general fleet uses. These trucks were acquired as part of a project lead by the environmental team, so the interviewee was not aware of why they were acquired or where they are fueled. The interviewee noted that the fleet is, "very adamant about staying away from diesel" and they are, "looking into electrifying [their] entire fleet," though the current fleet is nearly 95% diesel. Company 25 is in a city that does not allow diesel vehicles, and as such they are required to get permission from the environmental team, and the city to run the trucks. He believes that there is a regulation for Fleet 25 to electrify 7% of their vans and box trucks by 2025, although it is unclear where this came from or if it is codified. He believes that CARB and the city they operate in were the ones that directed them to move away from diesel but is not sure. Company 25's interest in electrification came out of Governor Newsom's executive order to electrify fleets by 2035 (made November 2020) and they began discussions for how to achieve this in January 2021. The interviewee said that the environmental team, "the guys that deal with ARB and all those incentives and stuff" (he could not remember their job titles), and himself are responsible for transitioning the fleet. While they are required to electrify, Company 25, and thus Fleet 25, is aiming to accelerate adoption beyond what is required so they can be viewed as a leader. Fleet 25's customers (various departments) are unhappy about the transition and worried that the trucks will not be able to meet their needs. The interviewee notes that this shift has been challenging for him as well, stating, "I know a lot about internal combustion engines and how they work… but once you start talking about electrification, I have no idea what I'm doing." It will primarily be his responsibility to learn about electric vehicles on the operations side, although he does have some help from those in charge of funding the infrastructure and vehicle purchases.

Interview Summary for Fleet Number: 26

1. **Region:** Southern California, Los Angeles-Long Beach Port District
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 12 Trucks
4. **Truck type(s):** Class 8 (specialized for heavy-weight)
5. **Use-case(s):** Drayage, heavy-weight (special permits)
6. **Buy or Lease:** Purchase, 1 leased
7. **Purchase condition:** New and used
8. **AFVs:** No

<u>Keywords</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Simple

<u>Summary</u>
Fleet 26 began operating in 2018. It specializes in overweight drayage. They operate mainly out of the Los Angeles- Long Beach port district where they have a warehouse. The trucks bring boxes from the port to the warehouse and “weight reduce them.” Additionally, they cover “all of California and Nevada and Arizona delivering this service for vehicles and customers.” The fleet is composed of 12 Class-8 trucks which are specially designed with an additional axle to carry more weight (they have permits that run up to 95,000 lbs.) than a conventional two-screw vehicle chassis. The trucks are custom built and either manufactured directly from the dealership or purchased secondhand “within a three or four-year usage time.” At the time of the interview, the fleet was composed of vehicles in the 2015-2022 year model range, but all their current trucks are CARB compliant. They’re currently leasing 1 truck from a dealership in Southern California.

Fleet 26 is family owned, though the interviewee is solely responsible for vehicle purchasing and leasing. He has worked in the fleet industry helping corporate fleets build and grow their fleets for 30+ years. The fleet has had rapid growth in the last 3.5 years with the acquisition of a warehouse in mid-2019 that allowed them to “further expand services.” When it comes to overall decisions for the company, the interviewee does rely on “other employees and staff members that help [him] with the safety end of things and keeping things in compliance.”

When purchasing or leasing a vehicle, the fleet considers several factors. For new purchases the “primary” factor is *“CARB compliance for the state and LA- Long Beach ports.”* After that it’s the availability of specialized equipment for their niche business. *“Length of the wheelbase, weight, we're very sensitive to weight, and that being lighter means I could increase our payload to our customers, and that's the value.”* Legality/safety is also a driving factor, with the interviewee noting, *“there's a lot of containers today that run in and out of the Port of LA-Long Beach that run illegal. It’s a known factor, everybody knows it, there's so many people out there that are running containers now, they'll close their eyes and they’ll run them risking so much that in the court of law it turns into a criminal offense. So, for me, we want to continue to run things legally, do things by the book… there's a very small portion of guys that do it right.”*

As far as homogeneity or brand preference, Fleet 26 is “open to all makes, brands, and models,” if they can meet requirements, especially low-weight (no extra features such as day sleeper or day cabs). They have been successful with Freightliner, Volvo, and International trucks. The company recently acquired a second truck with International West Truck Models and they’re “very, very happy with it,” noting that if they needed to replace a truck tomorrow, they would “honestly probably do an International.”

Regarding retirement, because Fleet 26 carries such heavy loads, they go through trucks more quickly than the average fleet. They also go much slower than what regular traffic is flowing—“vehicles with 95,000 pounds, were traveling 30 to 35 miles an hour on surface streets, versus the guy who's going 50-55 miles an hour, so it takes a lot more toll on the vehicles with the weight.” At times maintenance is the first thing that triggers the need for retirement/replacement. Typically, they look at engine-hour times, especially if the truck has low miles, “it's very common that it has high engine hours, which equates to a truck that has doubled, tripled the miles that it actually is recording.” They also look at “what that cost would be versus leasing a vehicle, lower maintenance costs and longevity with the vehicle.” When they approach trucks with higher miles, they “decide if it's the time now to start retiring or swapping them out for a newer truck,” considering the growth phase.

They have in-house maintenance for “light mechanical things,” but for more severe fixes like “a clutch job, transmission, or axles, or anything that has to do with the suspension,” they take it to a “local shop.” Trucks that are under warranty are taken *“directly back to the dealership, so we have three different service connections.”* When it comes to service, their safety department keeps track of those records. They track maintenance through Teletrac with Telenav, a device that's connected to all their vehicles, to “keep them in compliance.” The software uses dash cams, hours of service for the drivers, and tracks the mileage, and engine hours. It also allows them to do updates with their pre-and post-inspection with their drivers, track all the maintenance, and track the life of the vehicle. *“And then of course we approach these vehicles with the higher miles, we then decide if it's the time now to start retiring or swapping them out for a newer truck. And again, we're still at the growth phase, we're still building our fleet, I’m sure pretty soon we'll, we'll probably look at doing that for the rest of the trucks.*”

Typically, once they’re done with a truck, “there's really no value left.” The interviewee noted, “The equity in that truck has been depleted to almost nothing once you drive off that lot typically right away with a new truck but uh, the older vehicles, yes, there is a program that the State of California AQMD offers where you retire an older engine model, there's criteria for that, and they’re then just retired straight to the junkyard and we swap those out for newer trucks along with the with the grants that are provided.” They currently have three right now that are entering into the program and it's about a year long process to vet a truck and get them applied.

Aside from the AQMD incentives and programs, they typically fund new purchases through typical conventional bank loans. They’re not aware of any other incentive programs. They do not currently operate any AFVs, but said they are looking into CNG. He said he has “some mixed feelings, just making sure for us that we don't lose our horsepower and drive distance and fueling locations, there's a lot of things that come up that we want to make sure that our uptime is still there. But we are looking at that type of fleet at this moment.” They would be “very open and interested in” demoing an electric truck but haven’t investigated it yet.

Interview Summary for Fleet Number: 27

Decision Making Keywords: Proactive, sole
Region: National
Ownership Model: Driver-Owner
Fleet size: 1 Truck
Truck type(s): Class 8
Use-case(s): Long-haul
AFVs: No
Purchase condition: Used, purchase

Keywords
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: Interviewee purchases trucks based on *compliance regulations* for 2010; while he currently has a used truck, his next truck would be new with the best *fuel economy*; he prefers Volvo due to their *"durability, reliability, and uptime"*.

How are they used: Fuel economy is his strongest purchase consideration because of the cost savings that pays for itself. Out of the trucks with the best fuel economy (Volvo and Freightliner), he would choose the one with the best durability and reliability to help minimize downtime which is costly.

Summary
Interviewee 27 is the owner-operator of a single-truck, long-haul fleet that operates nationwide. The interviewee got into truck driving as a late career change because it has a low barrier to entry and allowed him to, "be the master of [his] own destiny". Prior to trucking he was a commodities trader and a mortgage broker and has an MBA, as well as a chemical engineering degree (he began looking for another career during the 2008 recession). He heard that to get insurance as an owner-operator, drivers need two years of experience, so he worked as a company driver for two years before leaving to become an owner-operator. The interviewee has only purchased one truck, a used 2011 Volvo which now has over 1.1 million miles on it. He purposely purchased a truck that complied with the 2010 CARB regulations. He has also driven new, pre-production trucks as a part of a testing program that he stumbled upon. While waiting for his truck to be repaired at a dealership, the interviewee saw the new truck, which he recognized as being pre-production. He asked if they needed any test pilots and they agreed to hire him on for the role. Fixed-route testing did not pay as well as being a normal freight hauler, so they agreed to make him a field tester. The testing has since stopped due to COVID.

He notes that if he were to purchase another vehicle in the future it would be a new truck because of the greatly improved fuel economy, which is his biggest purchase consideration. While his current truck is from 2011, it gets 8.5-9 mpg. For a new truck, he would like to get 11-12 mpg. His test truck had a very small 11-liter engine which was more than adequate and he appreciated the fuel savings. He would only consider trucks with “superlative fuel efficiency”, which only Volvo and Freightliner offer. Out of these two, he would choose the Volvo because of their “durability, reliability, and uptime”. Having tested vehicles for multiple brands now, he believes they have the best technology (he even is a moderator on a Facebook group for Volvo trucks). He takes pride in having a truck with superior fuel efficiency and profitability, rather than being flashy. He would also consider how nice the trucks are to drive (noise, ergonomics, dynamic steering, etc.) because it relieves some of the stress of driving. He also prefers the truck components that are more integrated where “each additional component talks to another” (e.g., automatic transmission) because it is easier to drive and safer in rough terrain. He can drive and shift easily with fingertip control “like playing a game”.

Fuel economy and aerodynamics are the most important considerations for his purchases because they “pay for themselves many times over, often times within the first year”. He thinks trucks should be made as aerodynamic as possible and claims to have “the most aerodynamic rig on the roads in North America,” and “all of the emissions equipment”. The interviewee has a patent on a fuel saving trailer skirt which he helped design with Windyne. He uses it on his truck along with a nose cone, trailer tail, eco flaps, wide- based single tires, and cab side extenders. Going “as aero as possible” has noticeably reduced his fuel consumption. He can also lift an axle on his trailer for light loads. Because his test tractor (a 6x2) also allowed axle lift, he recalls one trip where he only used 3 of 5 total axles for what was “probably the highest fuel economy ever posted by an over the road truck carrying a load”.

He would investigate replacing his truck when the maintenance costs and fuel balance out compared to the costs of a new truck with less fuel use or when the reliability begins to become an issue. He meticulously tracks all his maintenance and repair costs, fuel economy, daily odometer readings, cargo weight, fuel used while idling, and what aerodynamic technologies are in use. He started this practice years ago to determine if a particular fuel saving technology was a good investment. While the truck currently has over 1.1 million miles on it, he believes it can get close to 2 million miles before he would need an engine rebuild or would sell it. This is a much longer rebuild interval compared to most non-Volvo tractors.

While he has thought about electric trucks, the interviewee would not consider getting one because there is no infrastructure in place to support it. If he were to get an electric truck, it would need to have a range of 600 miles and be able to recharge overnight. He notes that while this would work for him, it would not work for trucks that run in dual shifts. If the truck had to make an extra stop to recharge once a day/shift for up to a half hour, this would be acceptable. However, two extra half-hour refueling breaks per day might become a little too “invasive”.

He has two determinants for replacing a truck: 1. when maintenance costs get too high and 2. when reliability drops. Reliability concerns are based more on downtime and missed profits rather than repair costs. Associated with the Volvo and Mack Facebook pages, he also administers two buy-sell pages for those tractor types.

The interviewee is retiring from truck driving because of a medical issue but has started a new testing and consulting company created to advise fleets and truck drivers.

Interview Summary for Fleet Number: 28

1. **Region:** Western U.S.
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 22
4. **Truck type(s):** Class 8 (some owner-operated box trucks)
5. **Use-case(s):** drayage, last mile delivery
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New (current model)
8. **AFVs:** None currently, but interested

<u>*Keywords*</u>
Decision Making Structure: Egalitarian, Hierarchical
Adaptability: Mixed
Complexity: Simple

<u>*Summary*</u>
Fleet 28 is a subsidiary of a larger company which has thousands of trucks that does trucking between California, Arizona, and Nevada. Fleet 28 is a drayage fleet headquartered in Oakland, but the fleet is in Long Beach. The parent company of Fleet 28 has a “harbors division” that deals with drayage of containers out of the port. The harbor division moves “fulls coming out of the harbor and going and doing deliveries or whatever in California, or wherever, and then their empties would go back.” Fleet 28, however, can make its own decisions because they do the “opposite,” where they “take in fulls because then we're shipping them on to Hawaii and Guam and of that nature.” Essentially, the interviewee describes the breakdown as the parent company having “two totally different divisions,” the harbors division and Fleet 28. Regarding truck acquisition and retirement, the only approval Fleet 28 needs from the parent company is from the single owner. In the interviewee’s words, “we communicate with him, but no we're not going through any other personnel at the parent facilities to purchase vehicles. It would just be speaking with our owner and advising them, this is the direction we're going to go, this is what we're looking for, and getting his approval of course.”

Fleet 28 has 22 Class 8 tractors that are all driven by company-drivers and owned by the fleet, but also contract with some owner-operators who make up the company’s “straight truck fleet,” and use “the smaller box trucks with lift gates.” They use owner-operators for the box trucks because “those types of vehicles are a very highly expensive vehicle to purchase, a lot more wear and tear, a lot more maintenance.” The interviewee says this set-up works for them currently, noting the owner-operators “have their own businesses, they're their own businessmen, they service other customers and so forth.” They need the smaller trucks to operate in the tight areas such as downtown Los Angeles where they can't take large trucks, containers, 40-foot, 53-foot trailers. The owner-operators have no influence on the fleet decisions because they are their own business and provide their own insurance. “And because those trucks aren't going into the port, they don't have the initiatives of certain things, though there are certain initiatives obviously through vehicle tax and so forth with the state that they're applying, having to meet, but it's a lot less than the vehicles going in and out of the port.”

Fleet 28 purchased their current 22 Class 8 tractors new about 4-5 years ago when they traded in their entire existing fleet for a new Volvos. The impetus for this entire fleet trade-in was the new emissions regulations in the Port of Long Beach. The timelines of upcoming emissions regulations meant some of the fleet wasn't going to meet the standards, so the interviewee described trading in the entire fleet as the "best option," noting the "warranty and maintenance" created an ability to "shut down our mechanic shop and reduce those additional costs." In addition, the new warranty with Volvo reduces downtime because during "a large repair, the truck would be swapped out and taken to a Volvo shop that then they would do their own repairs at their own location and bring the vehicle back when completed."

In the past the company purchased "a little bit of everything," whatever they felt was "the best bang for the buck." This was a departure from how they had previously purchased trucks. They were mostly motivated by the emissions mandates, stating, *"the State of California emissions [standards] continue to increase and the harbors even are, even California has their own laws, but the harbors have some very strict laws that are actually higher than just trucks that can be driving on the normal roads within the state. So, in order for us to have that harbor's compliance, we had to have the higher vehicles, the newer vehicles, so at that point in time it changed our purchasing direction, and we went to basically buying brand new."*

The company has never previously been brand-loyal. In deciding to go with Volvo, they "shopped around," before deciding Volvo trucks were the "best option and best vehicle out there for the price." They considered price, "maintenance package," "the long-term of that warranty package and things of that [nature] that they would provide with the services they were going to provide long-term over a five-year span period." The interviewee said typical maintenance contracts are around two-year, but Volvo offered 7 years total. This extended warranty was the primary factor that sold them. The interviewee explained, "with the maintenance and everything else set up for them, preventive maintenance, that has to happen four times a year, and so forth… so getting that extended warranty was large in our decision."

The interviewee tracks expenses through their IT and accounts payable departments. They don't like to lease because when "you go into a lease, you're not really owning your assets and we like to own our assets, we own all our buildings, we own all our properties, so we're, you know, so we don't rent, we don't lease, we purchase. We can control our costs that way too, that's the biggest thing is by owning, you control your costs."

With regards to turnover, beyond the "easy swap out" they dealt with in Los Angeles because of ports regulations, they typically have mechanics look at different factors, "we check the oil and inside the oil it's got break, you can check your breakdowns and how much stuff. We look at vehicles of how much maintenance has happened in that vehicle in the past year." The interviewee said typically in Hawaii he's always purchasing vehicles because he's "always swapping some of the older ones out. "He says that "luckily in the state, when we go to sell, there's still people looking to buy, because again there's no mandates in the state on any type of regulations of vehicle years or anything like that on the road. So, luckily right now, still in the state I'm able to sell locally and not have to ship something back to the mainland."

Because of new emissions regulations coming out, especially in the harbors, and as they hit the five-year mark, they're considering turning over the entire fleet again. The one difference this time is that they're also looking at "other factors on the electrical side (AFVs)," and "starting to look at that in our next future purchase direction." They've been doing "a lot of conference calls with some people and talking to them about vehicles, and I know there are a lot of companies that are trying to work on the trucks." The interviewee's biggest concern with electric trucks is the battery weight, "it's really adding a lot of weight to the trucks which then takes away the capacity, you can load in containers because you have a max capacity with the state on driving a truck on a highway, so if the batteries are heavy, you reduce your cargo, then you reduce your revenue and so we're hoping that they can lighten the batteries." They also see the state being able to "step up" to help technology adoption by "extending maybe the gross weight maximum capacity up an extra 10,000 pounds, knowing that that allows people to go into electric vehicles that the vehicle's already heavier." The interviewee thinks regulators should not "punish the people trying to meet the expectations from the State for having to take less revenue on because you're putting a demand on us. But then not allowing us to charge the full revenue that we should be getting."

The company is still trying to figure out what the best technology would be for their use-cases. He said they would prefer the "vehicle to charge itself as it drives," so they don't have to plug-in every night in the evenings and charge the batteries. They note their biggest challenge is some of their vehicles are used during the day and at night (two 10-hour shifts).

They're especially interested in using greener trucks in Hawaii, because of the state initiative to be green by 2035. However, the state is not providing any incentives for businesses, which creates another large challenge in the way of "a large amount of cash" needing to "come out of pocket." In addition, it's a much harder secondary market to sell vehicles on the island, so they'd have to pay an additional 5-10 thousand dollars per vehicle to ship it all the way back to California. The interviewee also noted that California's rules and regulations means that "sometimes the vehicle just becomes scrap." He noted, *"so you have a piece of vehicle that could run for another 5-10 years but it basically becomes useless. So, there's no incentives from the state or the federal really right now to really push this goal of going into that, you know, alternative fuel mode, you know."*

Interview Summary for Fleet Number: 29

1. **Region:** Nationwide
2. **Ownership Model:** Owner-operator
3. **Fleet size:** 1 truck
4. **Truck type(s):** Class 8 reefer
5. **Use-case(s):** Long-haul
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** No experience, no serious interest

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Mixed
Complexity: Simple

Inputs to decision-making: Vehicle spec preferences, regulatory compliance, manufacturer relationship, maintenance cost

How are they used: Driver has very specific vehicle needs and comfort preferences which fall well outside stock vehicle designs, thus limiting manufacturers. After-purchase manufacturer relationship is very important, it keeps him brand loyal. Maintenance costs and California regulations influence the life cycle.

<u>*Summary*</u>
Fleet 29 is a long-haul, single-truck, owner-operator who moves general goods and specialty products requiring temperature control. He is a 55yr old driver who has been driving for about 30 years (owner-operator for 9 years) and owns his own tractor, chassis, and trailer which he described as his last before retirement. He purchased a reefer unit to add versatility and, over time, has carved out a niche delivering hazardous chemical loads that must be temperature controlled. It is a Model Year 2020 and he plans to eventually rebuild the engine in 8-9 years to get 2 million miles out of the truck, while keeping it "as Cali compliant as [he] can". A new Cali-compliant tractor is $180K and he does not want to deal with payments after turning 60 years old.

Fleet 29 operates nationwide but makes an annual trip to Alaska. He keeps track of fuel usage on an app but has pre-calculated that he needs to make a gross revenue of $1,100 dollars a day. He has distilled all costs down to this daily revenue need. If the load doesn't pay $1,100 / day, "it's cheaper for me to keep the keys in my pocket". Consequently, he cannot compete in a lot of short markets (e.g., 150-200 miles) and he is okay with that. He has been driving for 30 years and things are good right now (e.g., revenues are high due to demand created by the pandemic), but he has been through many lean times, so he is taking as much business as possible and trying to reduce his operating costs through aerodynamic features (e.g., super single tires, global aerodynamic kit).

In the 9 years he has been an owner-operator, he has had 3 trucks. The first was a lease/purchase with Schneider National which ended because of an accident in 2012. He has financed the last 2 trucks and trailers through the Kenworth dealership. His last tractor was six years old and had approximately 770,000 miles when he retired it. I was approaching time for an $40K engine rebuild. Fleet 29 decided it would be cost-wise and easier to keep compliant with regulations if it purchased a new tractor. The detailed specs on his new tractor may have also played a role in the decision. While he is not dedicated to a certain product, his business relationship with Kenworth is very important. They have “spotted” him when unable to make payments, provided good credit terms, assisted him with road repairs, promptly took care of warranty issues, coordinated with other dealers for maintenance when the interviewee was out of town, and he likes the people at the dealership.

Fleet 29 has specific truck needs that steered his last purchase. His truck is a custom specification with a 13-speed manual transmission which is rare. He prefers it for his trips to Alaska in the snow and mountains (does not like automatic transmission deciding when to shift because it can be dangerous and he doesn’t trust it). Likewise, he opted out of radar brakes and other “safety” technology because he does not like to relinquish control of his truck. Comfort features (e.g., heated seats) are also important to him because the truck is his home “200 plus nights a year”. He had a “cow catcher” installed in case he hits a large animal in Alaska. He also had his current tractor spec’d special for his size (he is 6’ 6”, 300 lbs.) to get the steer axles to scale right. He also put a super heavy duty front axle on to run heavier weight on the steer tires.

He has never had to worry about reselling a truck (last one was a dealer trade), but he is confident that he can get a private cash sale and the truck will still be good for local or intermodal service. The interviewee decided to retire his old truck because the maintenance costs were dramatically increasing ($14,000 to replace the emissions system). He then had to wait for the new truck to be built and for the next tax year to make the replacement.

Fleet 29 is a seasoned veteran who knows exactly what he wants regarding jobs and equipment. AFVs are not a good fit with his long-haul job and he has no near-term interest in them because of a lack of infrastructure, weight, and range, especially in winter and with the hoteling load. He has also heard from other fleets who operate natural gas trucks but doesn’t think these would work for him either.

Interview Summary for Fleet Number: 30

1. **Region:** National
2. **Ownership Model:** Owner-operator
3. **Fleet size:** 1 truck
4. **Truck type(s):** Class 8
5. **Use-case(s):** Goods movement
6. **Buy or Lease:** Buy
7. **Purchase condition:** Used
8. **AFVs:** No experience, no serious interest

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Facebook groups, purchase cost, fuel economy, safety, and brand familiarity.*

How are they used: Fleet 30 has very basic truck needs. He uses social media (especially one manufacturer's Facebook group) for information, but purchase price is the primary determinant for track acquisitions, and the reason he buys used trucks. He tracks his fuel economy and uses when comparing trucks. Brand familiarity is also an important purchase determinant. A single safety feature gives the edge to one manufacturer.

<u>*Summary*</u>
Fleet 30 is a long-haul, single truck owner-operator who moves general goods. A driver for 7 years and owner-operator for 3.5 years, he bought a used truck in 2017. He made sure it was California-compliant so he would not have to restrict his routes to avoid California (although he has difficulty explaining how he ascertained that his truck was California compliant). His selection criteria were simple: relatively low mileage, decent horsepower, good fuel economy, a fridge, and an auxiliary power unit. Regulations were not the motivation for the APU purchase. To improve fuel economy, he uses aero tabs and a fuel additive. Recently, he also purchased a trailer.

Entry into the owner-operator space was largely guided by a podcast called Let's Truck (produced by Kevin Rutherford), a Volvo Facebook group, and, to a lesser extent, other various Facebook groups. These were primary and critical sources for learning about matters such as fuel economy, mechanics, and Landstar services. On the advice of his previous employer, he drove for 2 years before buying a truck to make sure he liked the profession and lifestyle. He "loves it".

Fleet 30 relies heavily on Landstar for work assignments, cost savings practices, operational advice, repair/maintenance payment plans, load insurance, and other things. He used to also use a Landstar trailer but recently purchased his own for better maintenance monitoring and to eliminate the Landstar trailer fee (7%).

Fleet 30 will probably stick with Volvo for his next truck. He drove Kenworths as a company driver and had no complaints. However, Volvo has a steering wheel airbag which he likes. He also has a good relationship with the Volvo mechanics, and he likes Volvo's aerodynamic shapes. Fuel economy is also an important purchase consideration. In addition to the aero tabs and fuel additive, he runs super single tires and installed an oil bypass system (extra filter) to improve mileage and reduce maintenance cost.

Operating and maintenance costs are recorded and monitored by a third-party bookkeeping company. He sends all his receipts to the company. This is strictly for his benefit. Landstar is not worried about cost, but every 120 days requires an update of any maintenance and any changes made to the truck.

Electric trucks won't work for him because he travels 700 miles at a time (11 hours driving followed by 10 hours rest). His concern with LNG and CNG is refueling station availability. He couldn't think of a cost savings differential or a convenience factor that would spur him to switch to CNG.

Fleet 30 uses several online resources to help him in every aspect of his business from choosing mechanics, buying aftermarket devices, choosing the right fueling stations, recording maintenance and operating cost data, route selection, and even finding the right truck. He optimizes routes to minimize fuel costs, fuel taxes, tolls, and other costs. He uses phone apps, Landstar services, trucker GPS programs, maps, and social media to get up-to-date information.

Interview Summary for Fleet Number: 31

1. **Region:** National
2. **Ownership Model:** Owner-operator
3. **Fleet size:** 1 truck
4. **Truck type(s):** Class 8
5. **Use-case(s):** Long-haul
6. **Buy or Lease:** Leased
7. **Purchase condition:** New
8. **AFVs:** No experience, no serious interest

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: Trade subscriptions, social media, and other drivers. Familiarity, availability, and purchase price.

How are they used: Fleet 31 leased his current (and first) truck because it was the same one that he trained in while becoming a driver and his other preference was unavailable. He had few trucks to choose from because of poor credit. He hears and reads good things about Volvo. After his current lease term expires, he hopes to lease then buy a truck from Volvo. If nothing is available from Volvo, he will purchase the truck he is now leasing. Leasing appears to be an important “try before you buy” strategy.

<u>*Summary*</u>
Fleet 31 is a long-haul, single truck owner-operator who moves general goods. He began about 20 months ago as a company driver who leased his vehicle from the same company. The company offered him a limited selection of vehicles, which all had the same standard spec. After 18 months, he decided he was not going to make money driving for the company, so he leased his own new truck from a leasing company and became an independent driver. His tractor selection was somewhat limited because his credit score was not high (he picked a leasing company that did not focus as much on credit scores). However, the primary factor in his selection was familiarity with the truck. He chose the Peterbilt model he was trained in and the only one he had used since entering the trade. When he struck out on his own, he joined the carrier Landstar which helps him find loads, provides fuel discounts, and helps with finding locations and discounts for maintenance and repair.

He is already contemplating his next vehicle when his current lease expires in 3 years. He likes the comfort and drivability of the Peterbilt but the turning radius is horrible. He has heard good things about Volvo’s low maintenance and durability, so that may be his next tractor. There were availability issues that delayed his lease (he had to wait 3.5 months from purchase to delivery of his truck in May 2021), but they were even worse for Volvo, which swayed his selection towards Peterbilt. Sometime this year he is visiting a dealership to test drive a Volvo.

He gets information from several sources and is “subscribed to everything (he) can find”. He also uses social media and listens to peers. However, he takes advice into consideration only if he hears it multiple times. He appreciates the many safety features on his truck. He leased from Schneider Financial which doesn’t have optional safety features, “you get them all [safety features] or you don't get a truck from them”. He likes the leasing company because the down payment is low, even though he has bad credit (it helps that he signed on to a reputable carrier, namely Landstar, given that the lessor bases the payments on the carrier).

Landstar gets a percent of each load (35%) of which some goes towards the trailer rental (7%) and the booking agent (7%). Fleet 31 gets 65% for each load from which he must pay his lease and insurance. He does track fuel cost. He gets a discount through Landstar that shows up on his credit card about 15 minutes after refueling (he gave an example of a $57.9 cents/gallon discount on a recent refuel). However, he does not get a discount on tolls. Fleet 31 keeps all his expenses, “every truck expense he has” in a spreadsheet which he uses for budget projections. Fleet 31 has calculated that he needs to make $2.02/mile on a load for it to be profitable. This includes any deadheading.

He will focus on comfort, fuel economy, and safety for his next truck. He currently has “optimized idle” in the truck instead of an APU and prefers it because it is quieter. If his current truck performs okay (maintenance costs remain low) and a Volvo is not readily available, then he will exercise his balloon payment option at the end of the lease and buy his truck. If a Volvo is available, he will lease a Volvo tractor and then purchase at the end of that lease. He would prefer to buy than lease because the payments are lower.

Fuel availability is his main concern regarding alternative fuel trucks and range is an added concern for electric technologies (he mentioned that Freightliner’s electric Cascadia truck only gets 250 miles and takes 12 hours to recharge). He needs to drive 600 – 740 miles per day (10 – 11 hours). He’s spoken with UPS natural gas truck drivers who expressed frustration with refueling station availability. He could envision a hybrid-diesel truck purchase, if the range, truck availability, and refueling were adequate and there was a significant cost incentive, like a break on tolls or fuel tax.

Interviewee 31 is relatively new to trucking and is learning the business through a combination of sources such as other truckers and social media, leasing companies, and the carrier Landstar. He seems to have a good handle on tracking and understanding expenses. His goal is to purchase

Interview Summary for Fleet Number: 32

1. **Region:** National
2. **Ownership Model:** Driver-Owner
3. **Fleet size:** 1 Truck
4. **Truck type(s):** Class 8
5. **Use-case(s):** Long-Haul
6. **Buy or Lease:** New and used
7. **Purchase condition:** Purchase
8. **AFVs:** No

Keywords
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The interviewee purchases trucks with the best *fuel economy*; tries to purchase vehicles with the best *safety features* including crash mitigation, lane departure, and an electronic dash; specifying a truck with the best *comfort features* and that reflects his personality

How are they used: The interviewee purchases trucks with the best fuel economy to help save him money. He also purchases the most safe and comfortable trucks because he is driving so often.

Summary
Interviewee 32 is the owner-operator of a single truck operating long-haul across the country. The interviewee works as an independent contractor in three primary roles: moving general goods for Landstar (a freight company who contracts with owner-operators to move goods), moving music tour equipment for touring companies, and moving equipment for cheerleading competitions. When working with Landstar, Landstar posts the jobs, which are then selected for him by his Landstar agent. Landstar drivers make around 70% of the listed load value and the remainder is kept by Landstar and the broker. While Landstar requires its drivers to undergo a U.S. DOT inspection every 120 days (more frequently than required under law), they have no say over what trucks the drivers can purchase. As a Landstar driver, the interviewee receives "huge fuel discounts," which he can use even if he is not hauling a load for Landstar. The interviewee used to work as a company driver but switched to being an owner-operator so that he could run his own business and have more control over his schedule, which he believes to be, "kind of priceless."

The interviewee purchased his current truck used but is currently looking into purchasing a second truck that will be purchased new. The new truck is likely going to be a Freightliner Cascadia, "because they have all the whistles and bells." While he looked at all the major truck manufacturers, he chose the Cascadia because it has the best fuel economy, which was his strongest purchase consideration. He will be adding on aerodynamic features to improve the truck further because there is little that can be done to improve the fuel efficiency of the truck once it is purchased. He also tried to drive the truck as efficiently as possible (e.g., "feathering the use of the accelerator pedal") to improve fuel economy. Aside from fuel economy, the Cascadia was chosen because it has the new safety features including crash mitigation, lane departure, and an electronic dash. He is also trying to spec the truck that has the best comfort features and one that will, "reflect [his] personality as best as it can".

The interviewee does his own bookkeeping and tries to closely track all his costs through an app called "Keep Trucking". He is hoping to hire another driver to use his current truck but will trade it in or sell it if he can't find someone to use it. He is going to purchase his new truck soon because he is planning to drive for 6-7 more years and Freightliner offers a 6-year, 600,000-mile warranty, which would give him a "safety net" against future maintenance costs. "If I can get a warranty to cover everything until I turn the keys over to sell that vehicle to somebody else, that's a lot less headache that I have to deal with." To avoid having to repower the vehicle, the interviewee keeps up with the maintenance on his truck and has even developed relationships with maintenance people across the country who are "experts in their field". This includes a "suspension and tire wheel guy" in Kansas and shops that work on the engine or body, all of whom have "become part of [his] team".

He has very little experience with electric or natural gas trucks and has not yet researched them because there are no trucks that have the range he needs, there are not enough refueling/charging stations, and he "knows that there isn't enough information out there yet". While he was able to ride in his friend's Tesla (car?) and enjoyed its power, but he does not think it would work for him (Note: the interviewee was using what seemed to be his experience in the Tesla car to assess the Tesla semi–truck, which is not yet available). He used to be on the bleeding edge testing new technologies but now that he is coming to the end of his career, he is, "just wanting something that's known and true and tried and tested" so he can operate, "as cleanly and efficiently and with as less stress as I can."

Interview Summary for Fleet Number: 33

1. **Region:** U.S.
2. **Ownership Model:** Centrally-owned and owner-operator
3. **Fleet size:** 180 Trucks
4. **Truck type(s):** Class 8 tractors and 300 TRU trailers
5. **Use-case(s):** Long-haul: produce, dry goods, pharmaceuticals
6. **Buy or Lease:** Purchased
7. **Purchase condition:** New
8. **AFVs:** No experience

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: Best bid including lowest purchase price, aftermarket maintenance, warranty, and resale value. Ability to perform warranty work in-house.

How are they used: Fleet 33 develops specifications and then shops for the best deal through a bid process. They get several bids which they then leverage to get an even better deal. Bid assessment is not sophisticated or analytical but evaluated by comparing the decision inputs listed above. There is also significant flexibility about lifecycle which depends on replacement costs and the state of the used truck market.

<u>*Summary*</u>
Fleet 33 is a long-haul trucking company that transports produce, pharmaceuticals, and dry goods from the West Coast to the East Coast. The company owns their own trucks and trailers, but approximately 65% of the fleet consists of owner-operators (who pull Fleet 33's trailers). The interviewee is the general manager and former driver who oversees daily activities including office and shop duties (e.g., "everything as far as our day to day goes") and is the sole decision-maker when it comes to buying and selling trucks, although he sometimes gets feedback from others within the organization.

The purchase process consists of shopping around truck specifications among the different manufacturers and then negotiating for the best deal ("bid"). Their truck specs are relatively standardized and they gather quotes from "everybody". The bids are evaluated based on the purchase price, resale value, and maintenance costs. After bids are received, they negotiate to get a better price and warranty. Warranty terms are a major consideration and, along with upfront truck costs, one of the key components of a "good deal". Despite having their own maintenance shop, after-purchase service and the relationships needed for such service are also extremely important. Fleet 33 needs to be able to have trucks serviced across the country, so they need support beyond their own resources. The interviewee noted that "some people want to sell you a truck, but after they sell you the truck they don't really care anymore".

Fleet 33 operated Freightliners for about 20 years until the interviewee and his cousins bought out the business from a relative about three years ago. At that time, they decided to switch completely to Peterbilts because of their lower purchase price. They are now in the process of going back to Freightliners because they are certified to do warranty work on Freightliner, which makes repairs much easier and cheaper (the dealer pays them for the parts and the labor hours). Another reason for the switch was that drivers expressed concern that some of the safety features on the Peterbilts were more of a safety liability than a benefit (they would unnecessarily break on icy roads). Finally, despite their expected improvements in fuel economy (due to their smaller engine), the Peterbilts do not have high fuel economy and they require more maintenance.

After a year of driving for Fleet 33, drivers are offered a lease on a used truck from Fleet 33's inventory. After 3 years of leasing the truck, they own the truck (with no additional payment). Fleet 33 sees this as a smart driver retention strategy because drivers would otherwise purchase their own trucks and start a solo career ("If we don't give him the opportunity to have his own truck, then he's liable to leave. We're better off to put him in a truck and him still run for us"). For driving teams, Fleet 33 encourages and helps them to buy a new truck because teams can accumulate miles much faster (about 65% of their loads are driven by teams). Additional efforts to retain drivers include offering incentives such as monthly bonuses for miles exceeding 18K miles/month, best fuel economy, and least idling. They also use tractor mounted cameras to praise drivers for good performance rather than just using the cameras to reprimand drivers.

Fleet 33 has implemented a strategy to help mitigate the truck shortage problem (a tactic they first used in response to a truck shortage in 2018). Because new truck deliveries are delayed, they must extend the lifecycle of trucks in service. During these delays, trucks at the end of their service life continue to accumulate miles and depreciate. The depreciation can be significant if the warranty period/mileage is exceeded. Fleet 33's solution is to lock in the buyback price of the truck at the mileage the truck is at when the deal is made, rather than when the new truck is procured. By making this agreement with the buyback dealer, the trucks do not continue to depreciate while waiting for replacement truck deliveries.

Fleet 33 is very flexible regarding truck lifecycle. Service life for any truck is determined by the state of the used truck market and estimated truck replacement cost. This is not a very sophisticated process, "I'm not tech savvy so I don't do spreadsheets very well." In a good market, they try to replace trucks when they reach approximately 340,000-390,000 miles. This often allows them to sell the truck with around 200,000-250,000 miles of warranty remaining, increasing the resale value. Fleet 33 has purchased some aerodynamic technologies for their trucks, however, because of the nature of their service, it is difficult to determine the effectiveness of those technologies. They have conducted crude vis-à-vis experiments with different technologies.

All Fleet 33 tractors are 3 years or newer and their trailers 5 years or newer. The relatively short turnover interval ensures their equipment is always under warranty. The short turnover also means they do not have to worry about emission regulations impacting operations. All their tractors are equipped with APUs to help reduce idling emissions.

Fleet 33 feels that electric truck viability is "down the road quite a way" because the infrastructure is just not there. Also, long-haul demands make electric trucks a non-viable option. However, they have purchased a couple electric APUs to evaluate.

Interview Summary for Fleet Number: 34

1. **Region:** U.S., Canada
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 2,424 trucks (50 HDV, remainder MDV)
4. **Truck type(s):** Class 2B-6, Class 8
5. **Use-case(s):** Product delivery and servicing
6. **Buy or Lease:** Purchased
7. **Purchase condition:** New
8. **AFVs:** Currently investigating

Keywords

Decision Making Structure: Hierarchical, egalitarian, sole
Adaptability: Mixed
Complexity: Complex

Inputs to decision-making: Trial and error, after-sale service (especially warranty service) and relationships, operating cost benchmarks, residual value calculations, *"do the right thing attitude"* within organization and tax strategie*s*

How are they used: Fleet 34 is large enough to try different trucks and ownership models and then choose winners. They switched from leasing to purchasing in response to a new tax law. They calculated average operating costs benchmarks which are used to increase service life. Individual stores have a lot of autonomy so they can purchase an electric vehicle that may not show a favorable ROI. This is justified by the company's unwritten policy of "do the right thing".

Summary

Fleet 34 is an international furniture/electronics/appliance store that uses their truck fleet primarily for deliveries and field visits (mostly repairs and item collection). They have 2,374 medium-duty trucks and vans (class 2B-6) and 50 class 8 trucks they use for long-haul to supply fulfillment centers. The medium-duty trucks are purchased new but the class 8 trucks are outsourced to big transport companies (outsourced pulling Fleet 34's trailers). These class 8 vehicle contracts are currently managed through a separate branch of the company. However, fleet 34 is beginning to out-source to a third-party logistics company, who will take over all their heavy-duty long-haul operations. This will help them reduce liability in case of an accident (medium truck accidents tend to not be as severe).

The interviewee is the fleet director for U.S and Canada and has six associates working for him. He is responsible for just about everything including purchases, vehicle disposal, registrations, handling accidents, and tolls, "anything that keeps the trucks rolling". In addition to in-house employees, Fleet 34 uses LeasePlan U.S and LeasePlan Canada to help manage the fleet. These companies provide an 800 number which stores can call if a vehicle needs service, there's been an accident, a truck rental is needed, and to deal with other issues beyond day-to-day operations.

Fleet 34 leased about 800 of their vehicles until the Financial Accounting Standards Board (FASB) rule went into effect (December 2018), which required companies to show equipment as capital. Since then, they have purchased all their vehicles with cash and bought out the remainder of their leased vehicles for $14 million.

The fleet profile and operations are the result of trial and error. Isuzu trucks make up the bulk of their fleet (they prefer the Isuzu badge over the Chevy badge) followed by Fords. The interviewee is loyal to both these brands, stating, “if I have an issue, I know who to go to, if I have a question about warranty, I just go to my main contact, and we get it taken care of.” Fleet 34 previously tried the Ram ProMaster (not a good vehicle for them), the Mercedes Sprinter (too expensive to operate), and others. Vehicle life-cycles have increased from 36 months to 48 months, to 60 months (where they currently remain) over the years. The 36-month turnover interval was for leased vehicles without a good maintenance plan. They started taking into consideration maintenance costs and pushed it out to 48 months and then 60 months after a more in-depth look at all operating costs (routine maintenance, body damage, and insurance). The interviewee, along with the accounting department, calculated an average of $1,100/month to operate the box trucks (including lease and depreciation), $995/month for their medium size vans, and $665/month for their smaller vans. This included factors such as maintenance, fuel economy, and physical damage to the vehicle. After showing the costs to the company executives, they were able to switch to longer timeframes and to purchasing vehicles (instead of leasing). Because of this change, they hired a management company to start tracking costs and taking care of maintenance issues and other fleet management tasks.

A typical purchase for Fleet 34 involves a national Isuzu contract and one of 3 dealers nationwide. Fleet 34 will make a purchase request through the dealers who will then arrange for the upfit of the vehicles. That is, they will equip the vehicle with a box, a lift gate, ramps, Etracks, GPS, wrapping and whatever else is needed. Then the trucks are shipped to specific stores. Purchases of other OEM trucks such as Ford, follow the same general process.

Fleet 34 truck purchases are budget-constrained but some years the CFO will say “hey we got some extra cash, go buy some more trucks”. Fleet 34 also prefers to purchase trucks through their dealers rather than through management companies (such as the company “Lease Plan” which they use for operational tasks) because if they over-order, they are not obligated to purchase from the dealers, which they would be if they purchased through a management company. They have very good long-term relationships with their dealers, even though everything is managed through Lease Plan. This is especially important regarding warranty service.

Whereas the class 8 drivers have very low turnover, Medium duty truck driver turnover is extremely high. However, it appears this has more to do with the nature of the business rather than driver satisfaction (driving a truck is just one part of a driver’s job responsibilities).

Previously, Fleet 34 worked with two “remarketing facilities” to dispose of vehicles. These facilities took the retired trucks and sold them through dealers or individuals. They “fixed them up a little bit” before selling. Now they use a different remarketing company, Flexco, which picks up the retired truck and takes it to auction. Flexco sends the bids from the auction and Fleet 34 decides whether to accept or decline them based on the residual value calculated by the interviewee. A second option is to sell them through Lease Plan or sell them back to the dealer. Fleet 34 no longer has a dealer's license, so they can't sell them directly.

Fleet 34 is receptive to electric trucks and is beginning to investigate Ford's E-Transit after being introduced to it by their Ford dealer. There is some concern that the drivers will not reliably plug in every night and the ROI will require longer life-cycles (maybe 8 years). However, there is a prevailing attitude throughout the company of "doing the right thing", which the interviewee attributes to being a publicly traded company. There is also a lot of autonomy granted to the individual stores, and the interviewee, who refers to himself as the buyer. The interviewee is currently waiting for Lease Plan to provide data on Fleet 34's carbon footprint in comparison to other fleets. The interviewee is looking forward to this benchmark and will continue pursuing clean options for the remainder of his employment before retiring in about 2 years.

Interview Summary for Fleet Number: 35

1. **Region:** Americas (North America, Canada, Mexico, Caribbean, Latin Americas)
2. **Ownership Model:** Mixed
3. **Fleet size:** 1,000+
4. **Truck type(s):** Class 4-6, few class 8
5. **Use-case(s):** Last mile delivery
6. **Buy or Lease:** Purchase and lease
7. **Purchase condition:** New
8. **AFVs:** CNG, electric (airplanes)

<u>Keywords</u>
Decision Making Structure: Hierarchical, egalitarian, siloed
Adaptability: Proactive
Complexity: Complex

<u>Summary</u>
Fleet 35 is a last mile delivery fleet. They have vehicles from Class 4-6, with a few tractor size vehicles as they do not do over the road (they do have airplanes). The interviewee is the director of fleet management for the Americas (North, Central, South America, the Caribbean) based out of the corporate office in South Florida. His role is to provide oversight and support the strategic decisions made by all the countries in their association and manage vendor relationships with major OEMs, to ensure that their countries are "utilizing the manufacturers that are preferred, the pricing and vehicle suspects." He is also responsible for approving and providing support for any business cases to either replace or renew or add vehicles to any of the fleets.

Fleet 35 is siloed and hierarchical with regards to decision making, with a self-described "bottom-up" process. The country level determines with the engineering support from their countries what their needs are based on their volume and the age of the vehicles they have in their fleet. They determine what they need to replace, what they need potentially new to accommodate new volume and then at that point they move it up to the regional office for approval and support— the interviewee's role—and at that point, they continue moving up the chain to a regional and global procurement support.

Fleet 35 has a procurement department, which is very involved with fleet management, there is an area of procurement that is dedicated specifically to fleet. The procurement team manages corporate level relationships with manufacturers and vendors that support the fleet side of the business. Their role is to negotiate and ensure that they are receiving global and regional incentives from business partners and manufacturers and that those are then being presented to the frontline country level management teams for review. After that, the local management teams at the country levels make the determination as to what type of equipment they need, what size, how many, etc. Once those determinations are made, they present their business case to the interviewee and other members of the regional office team that need to review it, such as safety, security. These teams make sure the vehicles meet company standards. The interviewee sees his role as being to "work with them [local countries] to ensure that it meets our guidelines." If he agrees with their decision about the "best case scenario for our country and what their needs are then we go to a regional CEO level approval and that point, it goes to a global approval before the final global approval for purchase."

Regarding replacing vehicles, there are company policies, which the interviewee described as "general global policy and general guidelines." The guidelines are "age or kilometer, whichever comes first." That number typically changes per type of vehicle. Smaller class vehicles may be a five- or six-year replacement cycle, class 6 and 7 trucks are more of a seven-year replacement cycle, and they don't typically hit the kilometer threshold because they are a last mile delivery organization driving in more urban environments. As such they "don't necessarily put a significant number of kilometers on our vehicles, so we normally replace them based on the years that are listed in our global policy."

Allowed manufacturers are established in the primary markets, meaning primarily North America, and some of the more industrialized countries in Latin America or Central America. At times there may be more leeway due to the availability of certain manufacturers in those markets. The major manufacturers that are used in North America are not necessarily available in many countries in Central America or the Caribbean, so therefore they need to be able to procure what is available locally.

The interviewee manages many of the vehicle choices though "there are only a handful of manufacturers that will actually produce the vehicles that are ideal for [their] business." The first thing the interviewee considers is the global procurement agreement they have with a vendor. Because of their global volume, the company often has "a very significant rebate from the manufacturer at the factory level… which makes those vehicles very affordable." That plays "significantly in North America, where the major manufacturers support us in those markets, meaning Mexico, US and Canada."

If there are one or two vendors, they have relationships with and are very affordable, "Fords, Mercedes Benz, or other global partners," then they take into consideration the resale value after a five- or six-year period, based on whatever the replacement cycle is for that vehicle. If there's a residual value based on the market for these vehicles. And, in turn, they develop "a TCO based on their average maintenance, fuel, and what residual value will be." They take in all those factors in determining what vehicle is the "most optimal and ideal for the market."

Every two to three years they reevaluate the TCO model because "new vehicle models come into the market," and the total cost of ownership for a newer vehicle becomes much more favorable as these new models come out. Even though their baseline for their older vehicles remains the same, they actively do this for the newer vehicles because "the story changes as vehicles become more fuel efficient and, in turn, that makes it easier to justify a replacement cycle that may be shorter for some models based on how more efficient the newer vehicles are."

They outsource their testing to a fleet management company who "options out the vehicles." They do not have any agreements with the manufacturers directly because they purchased the vehicles. At the end of the period of ownership, they auction the vehicles and use that as funding for additional vehicles. If the vehicle is leased, the lease will typically have an agreement with the manufacturer on how the vehicle must be returned.

With regards to purchasing vs leasing, in North America the company primarily leases due to the significant amount of expenditure that there is— " from a US and Mexican market, which are very large, the cap X needs to purchase vehicles at that value would be just too expensive. So, it's just a cash, upfront cash layout rationale that we wouldn't want to purchase 50 million dollars' worth of vehicles, as opposed to just leasing." For those reasons the company tends to lease in large markets. In the medium to small markets, they tend to purchase because "there is obviously fees associated with leasing, then, in turn, are not very favorable." He notes, "it's the market size and the cap X requirements for the size of the of the fleet that [they're] looking to support."

Fleet 35 has never encountered availability issues in the past, but this has recently become an issue. Right now, when they're looking for vehicles, they are considering what's available in the market. As a result, they may end up choosing "what we consider our second-choice vehicle just because it may be available a lot sooner than our primary choice."

When it comes to driver satisfaction, decision-makers "work with our employees to ensure that we get their feedback on the vehicles that we have." However, due to their long history and large number of employees they feel confident that they "already really know what [their] employees are accustomed to, what they expect from the vehicles that they have." They do note, however, they're always "actively including additional features that are available by the manufacturers to improve employee satisfaction level." Safety is more important than comfort. Some safety features like collision avoidance, "are not really available in the commercial market and our employees, of course, will give us that feedback" but once it's available they "do our best to include those."

In response to the "emissions regulations that are changing and becoming much stricter in the California market," they have "plans to ensure that the vehicles we procure meet those requirements." California and the Northeast are the two markets they "treat differently, because of the incentives and future outlook associated with electrification." The West Coast is one of the primary markets they look at to introduce zero emissions vehicles because it satisfies the current mandates but also "long term targets associated with emissions in the commercial space." They said they're actively looking at introducing those zero emissions vehicles as quickly as possible— West Coast first followed by the Northeast. The fact that California provides a "significant amount of support to purchase and or to upgrade your infrastructure to electrification" is a huge factor.

Fleet 35 has a global target of zero emissions globally by 2050. From a regional perspective they're looking at 50% by 2025 of their ground fleet being zero emissions. "So, we're not looking for cleaner, you know we do, we have done that, and we continue to do that, we look for a, a way to mitigate some of the emissions while we move towards electric but the really stated goal right now is 50% of our fleet by 2025 in all aspects of the region."

Fleet 35 has long been a strong champion of electric vehicles and has a publicized global mandate/policy to purchase zero-emission vehicles. In fact, purchase requests require the buyer to *"analyze their ability to purchase and integrate zero emissions vehicles in their fleet. If they cannot, they need to justify why (not) … they have to do a deep dive analysis to help us understand why we are not investing in zero emissions in that market yet, and when they propose to do so, based on their knowledge in the market."*

Fleet 35 purchased natural gas vehicles as steppingstones to electric vehicles before they were available (a way to become incrementally cleaner). They are currently piloting several fuel cell vehicles and (the interviewee believes) have even “signed an agreement for 12 electric (air)planes in 2023, 2024”.

Fleet 35 is capable, willing, and ready to do detailed cost analysis of electric vehicles but is stalled because very little data is available. Not many electric trucks are available in their needed sizes. However, Fleet 35 feels that they, along with their competitors, are accelerating electric vehicle market growth. They believe that, because of their collective size, manufacturers are responding to their requests for more electric vehicle models.

Interview Summary for Fleet Number: 37

1. **Region:** West to midwestern United States
2. **Fleet type:** Centrally-owned
3. **Fleet size:** 200 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Long-haul
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Complex

Inputs to decision-making: Cost per mile analysis, brand loyalty, maintenance cost and time.

How are they used: The owner of Fleet 37 is primarily motivated by the cost per mile analysis in their decisions of which truck to purchase. This includes insurance, maintenance, and internal mechanic labor costs, but does not include fuel costs. It also considers the maintenance relationship with the dealership and how fast they can get trucks up and running.

<u>*Summary*</u>

Approximately 95% of Fleet 37's business is hauling refrigerated food up and down the West Coast of the U.S. They also occasionally move equipment to and from oil fields in the Midwest. Fleet 37 has in-house maintenance facilities for routine work but outsources to a dealership for accident repairs. The interviewee for Fleet 37 works as the Safety Director and Fleet Manager. In his role, he works with the Maintenance Director to manage equipment purchases, replacement, sales, and repairs. He is in charge of researching and making the decisions on which trucks to purchase, however he needs the Maintenance Manager to sign off on his procurement decisions. While the owner of the company is not involved in the day-to-day purchase decisions, he has directed the interviewee to purchase Freightliner Cascadias, which they have done for the last 10 years. As a result, Freightliner Cascadias make up about 90% of their fleet. The interviewee notes, "it's his decision to prefer that manufacturer and our duty to keep that going". The owner is also the one who is in most frequent contact with the manufacturer's sales representative and developers to understand, "what's coming out for the next model year." The interviewee and maintenance director are not as involved in the model choice, which lies primarily with the owner "he simply gives us his recommendations and we vet it out, we do the research, and we confirm it or suggest something different".

The company purchases about 10 trucks per year with the acquisition process beginning 6-8 months in advance of their delivery. In the past year, this timeline has been extended due to the supply chain issues which have significantly delayed truck deliveries. Before the transition to purchasing mostly Freightliner Cascadias, the fleet had a mix of Volvo, Freightliner, and Kenworth trucks. The owner made the decision to stick primarily with Freightliner trucks because they have a better relationship for warranty and crash repairs than they do with other dealerships. The interviewee notes, “the speed at which they turn around parts is critical” and it helps the company keep their commitment to their customers. Sticking with Freightliner also helps save them money because Freightliners are, “cheaply built, but they’re also cheaply repaired”. The owner was further persuaded to stick with Freightliner because of the features available to spec “engines and such” and because of the cost savings associated with the maintenance.

When making decisions about which trucks to purchase, the owner regularly consults with his friends who also own fleets to understand how they like their vehicles and what their relationship with the manufacturer is. If he hears patterns of positive feedback and thinks there is enough cost savings to make the switch worth it financially then then work with the sales representative to work out a deal. They have not found any reason to switch over the past 10 years, so they have stuck with Freightliner.

The brand and model evaluation happens approximately once per year and a cost per mile (CPM) analysis happens about once per month. The CPM includes insurance, maintenance, and internal mechanic labor costs, among others, but does not include fuel costs, “because it’s so volatile”. It includes the purchase cost divided by 450,000 miles because that is the expected mileage of the truck and if it goes beyond this, “it’s the icing on the cake”. The owner of Fleet 37 compares their CPM to other fleets that the owner knows and trusts, but it is more about the CPM trend than the CPM of an individual truck.

Fleet 37 generally turns their trucks over when they reach 450,000 to 750,000 miles. The point at which trucks are turned over within this range is determined by looking at how much maintenance the truck needs. If it is prematurely getting more expensive than expected, then they take it out of the fleet sooner. They benchmark all their maintenance for 450,000 miles because this is how long the warranty lasts. Out of the 10 trucks they purchase annually, they retire and resell 6-7 and lose 3-4 due to crashes. If the cost of labor to fix a truck is more expensive than the cost to replace it, the truck will be taken out of the fleet even if it was not totaled. When the company is done with their trucks, they generally sell them to other fleets in the area that use the same manufacturer. They generally sell trucks through a local dealership but sometimes sell to retail or wholesale markets.

The owner is at the beginning stages of looking into alternative fuel trucks of all types, and they plan to order some to be delivered by Fall 2023. They would likely stick with Freightliner trucks so whichever alternative fuel Freightliner offers will be what the company investigates. They would want the cost per mile of the trucks to be on par with that of their diesel trucks because the owner is, “not going to spend money just to change the fuels. He wants to see that it is equal or better in CPM.” The CPM would also not be based on what the manufacturer reports as the owner wants to have other fleets make the investment first and calculate the CPM in their applications before Fleet 37 will invest. They would consider switching manufacturers only if the CPM was significantly better, but not if it was the same. The CPM metric also does not include any rebates or incentives because the interviewee was not aware of any that are available yet, only potential incentives that may be offered in the future. Once rebates are available, they still would not put a lot of meaning into them because they want the CPM to work out without relying on outside support.

Interview Summary for Fleet Number: 38

1. **Region:** National/Regional (Multi-state)
2. **Ownership Model:** Mixed (70% company owned, 30% owner operator)
3. **Fleet size:** 950 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Vocational with Power Take Off)
6. **Buy or Lease:** Purchase Only
7. **Purchase condition:** New Only
8. **AFVs:** None

<ins>*Keywords*</ins>
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Total mileage/years in service* is the main determining factor of turnover. Manufacturers' *service and relationship-building* influence their choice of a truck brand. *Consistency* in parts and maintenance incentivizes sticking with a few brands. *Niche operational needs* play a big role in what is feasible for the company.

How are they used: Decisions are made in partnership with maintenance, operations, and their drivers. The company has a strong relationship with Volvo and mainly operates Volvo trucks. Trucks are turned over to a reserve fleet at five to six years and sold around seven years.

<ins>*Summary*</ins>
Fleet 38 specializes in transporting cars to OEM dealerships. Operations are mostly in the Southeast, with some in California and the PNW. Their average hauls are 200-250 miles, but drivers can be out as long as three or four nights when doing longer hauls. Company-owned trucks are day cabs, while owner-operators are mostly sleepers. The interviewee is the founder and vice-president of the company and is responsible for truck and trailer purchasing and specs. Others who have input are the head of maintenance, the driver council, and operations staff. The driver council is nominated by drivers to represent different parts of the country and meets once a month with the management team.

Their truck cabs need to be short and low to maximize the number of cars they can haul. For the company-owned trucks, Volvo is their primary supplier, with Freightliner as a secondary supplier. Sticking to a few brands creates consistency for parts and mechanic training. The company has settled on two trailer setups: their "quick load" trailer is for domestic manufacturers and carries 9 trucks, while their setup for imported cars carries 11 trucks.

New trucks need to be modified to have a lower roof. They need specific vocational trucks that can be modified, which limits the selection to one truck model each from Volvo, Peterbilt, and Freightliner. They are all similar in price after modifications, so specs are much more important than price. The interviewee chose Volvo as their main supplier because of the support they received from the company. They also buy the whole warranty package. The company's shops and mechanics are Volvo warranty-certified so they can do warranty repairs in-house instead of having to go to the dealer.

The company has a few guidelines for trucks brought in by owner-operators but aren't too specific. They generally should be 10 years old or newer, and they need to be able to haul cars. They get inspected before joining the fleet.

After five or six years in full-time service, trucks become spare trucks, and at around seven years they get sold to the market. This lifespan is based on typical mileages of 180k to 200k miles a year. Some are sold directly to buyers, and some are sold through dealers. If they don't have enough value left to sell, they get scrapped. They are careful about how they sell trucks to avoid any one buyer staffing a whole fleet and competing with them.

The company keeps track of CARB through the California Trucking Association (CTA). They are also active through the auto hauler's association through the American Trucking Association (ATA), and they lobby for their own needs. However, they don't have much influence on what CARB does. They are also trying to lobby for exemptions to the 80,000 lbs. limit as electric cars are heavier and they can't haul as many with the current limits.

Given Fleet 38's market niche, batteries are too heavy and result in a loss of revenue. They are hesitant about natural gas for the same reason. However, the interviewee expressed interest in hydrogen and would consider analyzing the upfront and operating costs. They indicated the need to investigate where they would be able to fuel trucks and how those fit with their 40 locations across the country. In addition, a positive public image would be a benefit from using AFVs. There are no company clean fuel policies; rather, the decisions are economically driven. Their customers (car OEMs) ask about the environmental performance of their fleet, and it's coming up more often. They tend to get information from trucking associations and utility companies.

Interview Summary for Fleet Number: 39

1. **Region:** National (and International)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 7000 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (all types)
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** Both New and Used
8. **AFVs:** CNGs

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: *TCO calculations*, with emphasis on *total mileage*, *vehicle age*, and *maintenance costs*, are the main factors for fleet turnover. *Brand loyalty* stems from good *after-purchase service* and *long-term working relationships*. *Company ESG goals* and *customer interest* push the fleet towards AFVs, although concerns over *charging infrastructure* and a *lack of incentive funding* are key barriers.

How are they used: Fleet metrics are tracked with smart devices that connect to management software that calculates TCO. Through optimization, the interviewee is trying to speed up turnover to 7 years. Decisions are made with some input from executives and drivers.

<u>*Summary*</u>
Fleet 39 is a tank hauler fleet that transports fuel, food products, cryogenics, and other chemicals. The interviewee oversees fleet services, with some input from the president, the CEO, and drivers in the field.

The company owns (purchased new) mostly Peterbilt trucks with some Mack trucks in the U.S. and the reverse in Canada. Peterbilt and Mack work the best for their tank hauling operations. The company's relationship with these companies helped it to get what it needed during the pandemic. Other factors that feed into brand choice are customer service and a robust dealer network that provides service and repair. They look at their certifications, personnel capabilities, and ability to quickly diagnose and provide feedback. Occasionally, they add used trucks to their fleet through company acquisitions, although acquisition fleets are analyzed to avoid bringing "junk" into the fleet. Leases are rare and are reserved for special cases like liquified natural gas (LNG) trucks.

Owned trucks have a 9-year trade cycle, based on TCO calculations; they brought it down from 10 years and are working to get it to 7 or 7.5 years. Focusing on retiring older vehicles allows them to drive down the average. In-house TCO calculations incorporate cost per mile, fuel costs, driver satisfaction, downtime, resale value, etc. They track costs and review them monthly. The company has its own management software that connects with a device in each truck.

The company does about 70% of its maintenance in-house, and they are certified for warranty repairs. For retirement, there is a hierarchy of factors: Mileage, then age, then problematic costs (maintenance/repair). Used trucks pretty much just go by mileage for retirement, and the first to go are trucks that go over 750k miles. There is an overall 15% annual fleet turnover rate. The company has its own sales team that disposes of trucks. Non-running trucks are sent to auctions like Richie Brothers.

The fleet's specs can get specific: for example, they mainly drive on flat roads so 13L engines are fine. The tankers also need to have pumps, blowers, and hydraulic coolers.

The company's environmental, social, and governance (ESG) policies push the fleet towards cleaner vehicles. In addition, customers care about sustainability. The interviewee tries to stay ahead of CARB and works with SmartWay and the American Trucking Associations (ATA). They get information from ATA weekly updates, but also keep in touch with other groups. They are looking at another ARB emissions change in 2024, which is going to be costly.

The interviewee is interested in hydrogen and electric trucks. They don't see much value in pre-ordering trucks since they're still in the very early stages of production. They are concerned about the grid infrastructure required for truck charging, especially given grid issues like rolling blackouts. The interviewee believes that ZEVs are better applied in vocational trucks like waste haulers.

The fleet used to have some LNG trucks, but they phased them out. Currently, they have some compressed natural gas (CNG) trucks and are working on getting EVs. Used to have a peak of 150 NG vehicles, down to 70 now. They are hard to sell because they have little residual value

The company has taken advantage of Proposition 1B and HVIP funding in California, as well as Texas and EPA funding. They are on track to get a couple of battery electric vehicles through a Texas grant by the end of the year. The interviewee noted a lack of available funding. Issues include high upfront costs, short BEV duty cycle, and lost hauling capacity from the battery weight.

Don't think there is a driver shortage due to the pandemic. Just think that certain companies are struggling to keep pace with wages and benefits. Rather, the interviewee notes changes to the supply chain and cash flow. For example, companies must float the cash for fuel for longer

Interview Summary for Fleet Number: 40

1. **Region:** Global
2. **Ownership Model:**
3. **Fleet size:** 800+ trucks
4. **Truck type(s):** Day cab tractor trucks
5. **Use-case(s):** Chemical ingredient distribution; hub-and-spoke
6. **Buy or Lease:** Buy and lease (preference to buy)
7. **Purchase condition:** New
8. **AFVs:** Natural gas, battery-electric (one each so far)

Keywords
Decision Making Structure: Egalitarian
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: The two primary factors in the truck replacement decision are hours of service and maintenance costs. More recently, the company has had an increased sustainability focus, which has led them to a more robust turnover schedule and wading into the waters of alternative fuel and zero-emission trucks. California's truck regulations have been an important motivator.

How are they used: The fleet aims to replace roughly one-quarter of their fleet every year. Trucks are evaluated against one another. The trucks that are oldest (in terms of hours of service) and have the highest maintenance costs tend to be replaced.

Summary
Fleet 40 provides chemical ingredient distribution services globally. They are the top distributor of chemicals and ingredients in the U.S. The emphasis is on bulk transfers, but they also do packages as well, such as drums, sacks, bags or whatever the ingredient and/or chemical happens to be needed by the customer. The company does not manufacture chemicals but does offer blending services. The fleet consists of almost exclusively day cab tractor trucks, though they do have a few trucks with sleeper cabs.

Roughly 200 trucks are replaced every year – or about one-quarter of the fleet. Starting in 2016, the company aimed to move towards a newer fleet and retire the older trucks. This change was motivated by a desire to be better performing on emissions and satisfy regulatory requirements in California. Trucks in a particular model year cohort are compared against one another, and if there are outliers in terms of higher maintenance costs, then that truck is likely to be sold earlier than other trucks in that model year. In general, they have a target percentage of trucks that are replaced every year, and hours of service and maintenance costs are the two main factors by which trucks are evaluated.

They previously had mostly Peterbilt trucks but have moved to International (with the Cummins engine option), primarily due to their competitive costs and shorter lead times for acquiring trucks. International and Fleet 40 are both headquartered in the Chicago area, and that is a factor in their loyalty to International. If International is unable to fulfill their entire order (~ 200 trucks), then they opt for Peterbilt and/or Mack to fill the gap. Weight of the truck is also a factor in the purchase decision, and International trucks tend to be lighter than other brands (in Fleet 40's experience). The transportation division makes the decision on truck purchasing and then collaborates with the procurement, engineering, and operations teams to ultimately integrate the new trucks into the fleet.

Last year (2021), Fleet 40 made the decision to pursue sustainability through the purchase of alternative fuel and zero-emission trucks. They have a natural gas truck and a battery-electric truck operating in the Los Angeles area – both have been operating for less than a year. While the motivation is to improve environmental performance, it's unlikely they would acquire these trucks without the upfront purchase subsidies. Because of the higher costs of battery-electric trucks, the executive level of the company was more involved in the purchase process.

As part of the purchase of the truck, Nikola also provided a charging setup as part of the overall solution. Charging is possible at night, as the fleet is a daytime operation, making deliveries during customers' business hours (typically in the window of 5 am to 5 pm). The battery-electric truck has a weight penalty of about 10,000 lbs. This is a big issue for their operations and will increasingly be a factor as they add more of these trucks to the fleet.

Most of their maintenance is outsourced and trucks are sold to local auctioneers after being retired from their fleet.

Interview Summary for Fleet Number: 41

1. **Region:** California
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 400 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Short-haul
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: The fleet is loyal to Peterbilt due to their *quality, resale value,* and the fleet's *relationship* with the manufacturer. They also have some Kenworth trucks to avoid Peterbilt getting too comfortable. They purchase based on *industry knowledge, maintenance cost, use cases* (based on customer need)*, and relationships* with the manufacturer.

How are they used: The operations team gives feedback on the truck type, power requirements, truck specs, future capacity needs, growing the fleet, the number of trucks to purchase, and the turnover schedule. They nearly always purchase from Peterbilt due to their quality and relationship with the fleet, with one location purchasing from Kenworth. They can acquire used trucks through company acquisitions; however, they expect these trucks to meet their specifications and brand preferences.

<u>*Summary*</u>

Fleet 41 is a construction material hauler. Most of their fleet is made up of Class 8 trucks including "transfers, end dumps, bottom dumps, super tags, flat beds, and low boys." The organization's leadership includes a board of directors, a CEO, and three general managers (of which the interviewee is one). The majority of Fleet 41's purchasing is done by one of the owners with input on truck type coming from the operations team, which the interviewee is a part of. The operations team gives feedback on the truck type, power requirements, truck specs, future capacity needs, growing the fleet, the number of trucks to purchase, and the turnover schedule.

Fleet 41 typically orders 30-40 trucks per year. However, current supply chain issues are restricting this. They typically retire around 20 trucks per year and last year they ordered 34 trucks, allowing them to grow the fleet because "sales were really strong" (the interviewee believes supply chain restrictions began after this purchase was made). While the supply chain shortage is affecting their ability to purchase, Peterbilt has committed to fulfilling the fleet's typical annual order size this year. "We're currently still on a safe list to get our trucks this year, but that doesn't mean things change because, you know, they're all waiting on ships or headlamps or windshields and everything else."

Trucks are replaced on a schedule to keep up with CARB regulations. They also regularly change their fleet composition to add more of a certain truck type to one location or decrease the number of trucks at another location. They typically purchase Peterbilt-Paccar trucks with all their annual purchases typically being the same. Fleet 41's preference is for Peterbilt trucks because of the strong relationship they have with the manufacturer (the fleet even has their own "very distinct color" with Peterbilt) and Peterbilt trucks have a "premium resale value". The decision to purchase Peterbilt trucks based on the tradeoff of purchase, maintenance, and resale cost is less of a TCO decision and more of a "knowledge thing". The fleet's "ability to get in front of key decision-makers with Peterbilt, you know that's been, that's been built up over time. So yeah, it's a big piece though why we remain loyal to Peterbilt. We've just got a very rich history, they're kind of a legacy for us. They make the highest quality equipment out there, and for us it's worth the, the upfront initial, you know capital investment to pay more for those versus maybe a truck that we would have to then turn over more frequently or earlier in the life cycle, maybe not attain the same value capture with another brand." The interviewee notes that while, "you pay more for 'em, it's a quality truck for a quality application and that's a core value of ours." While most of the fleet is Peterbilt, they have Kenworth trucks in one of their locations because they are part of the same family of manufacturers (Kenworth and Peterbilt are both owned by Paccar). They purchase these trucks because "you never want to put all your eggs in one basket" and they "don't want Peterbilt getting comfortable in the relationship".

They are not as concerned with the warranty offered on the vehicle because they typically retire the vehicles before they hit the mileage minimum although they do consider parts availability and truck quality because "a parked truck makes zero money; it just costs you money". Most of their maintenance is done in-house.

The fleet typically purchases new vehicles but will occasionally take on used vehicles when they acquire a smaller company. They do not always keep the trucks they acquire through these company acquisitions because they are not spec'd in the same way that Fleet 41 prefers. They feel that their specs give them a competitive advantage, so they do not want to keep trucks that do not comply with this. When determining whether to keep a vehicle from a company the fleet has acquired, the interviewee looks at the condition of the vehicle, safety, capacity, miles, and how much longer they would be able to use the truck. They are also much more likely to keep a truck if it is a Peterbilt because it helps keep maintenance costs down because they already stock Peterbilt parts. It is rare for Fleet 41 to keep the trucks when they acquire a company and they have not done so with their last four acquisitions.

Driver recruitment and retention is their number one issue. This plays a small role in the number and type of trucks that they purchase but is not a large factor. "Typically, we run at, you know, kind of a 95-105% driver to truck ratio, and we're probably below 90% right now." The customers have more of an influence on which trucks they purchase (but not the number of trucks) because some contractors like specific truck types and the truck is determined based on the application.

Truck lifecycles are determined based on the overall truck condition, age, mileage, and maintenance requirements (both past and predicted future requirements). They don't have a typical retirement schedule, "it really is a case by case", but base turnover more on the general condition of the truck stating, "sometimes you know you'll have a cycle or a year of vehicle that just doesn't perform in the same manner." While they typically retire trucks when they reach 5-700,000 miles, a truck will be turned over sooner if it has "OEM issues" such as "turbo issues and emission control issues and sensory issues” which can “provoke us to turn over a cycle-year sooner than typical”. The individualized approach to turnover is needed because trucks are working in different areas of the state and under different conditions, so they are worn out at different rates. “The decisions that we made are just tried and true through, through experience”. While the truck shortage has increased the value of used trucks, they are not motivated to sell their trucks because they would not be able to replace them with new trucks. “Just knowing that we're not going to have any new trucks, not going to be able to add any capacity until maybe third or fourth quarter of this year, you're just kind of hold on to it, I mean it's just a business decision, right, to, not to, not to turn over some of that fleet”.

They typically resell trucks through brokers which are “primarily out of state, sometimes out of country”. They try to avoid selling through auctions because they don’t have as much control over the final sale price.

With CARB regulations becoming increasingly stringent, some manufacturers are beginning to say they won’t sell trucks in California or that they won’t sell certain products. These restrictions limit Fleet 41’s ability to compete in the marketplace, so they may have to look to another manufacturer. They will have to compare these drawbacks with the benefits of their technicians being familiar with the trucks and the availability of parts. “Our relationship with Peterbilt’s very strong and we're hoping, and we have had, them make exceptions for us”. “Here's the tricky thing, right, if they can sell to Arizona or they can sell to Nevada or Oregon, and those States come into, those trucks come into our state to haul interstate product, then it really doesn't accomplish what ARB’s trying to accomplish”. “As much as probably 50% of the freight movement in the state of California are trucks that reside outside of, outside of California”.

Interview Summary for Fleet Number: 42

1. **Region:** National
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 117 Trucks
4. **Truck type(s):** Class 2b-8
5. **Use-case(s):** All Heavy Duty and Medium Duty cases
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Brand loyalty* from the interviewee's boss prevents them from exploring certain options. Changes to the *accounting rules* for company-owned assets led to the company switching to exclusively leasing. *Mileage and CARB emissions regulations* are the two factors that determine fleet turnover decisions. *Low fuel costs* and a *public image* of being environmentally friendly are reasons to electrify, but this is hampered by the *time required to charge* slowing down operations.

How are they used: The interviewee evaluates these factors and makes most decisions, only needing a sign-off from the boss. However, certain decisions (e.g., trying out a GM vehicle) are out of the question due to the boss's preferences. Fleet turnover decisions are planned in advance and in concert with operations around the country. The interviewee is not fond of CARB but keeps up to date with regulations.

Summary
Fleet 42 provides construction services across the country, including operations in Washington, California, Minnesota, and North Carolina. The fleet is quite varied, ranging from concrete mixer trucks, and highway tractors, to Ford F650s, F250s, and other medium-duty trucks that can be adapted for use as dump trucks, flatbeds, and box vans, etc. Trucks are operated by laborers who often take a truck to a job site for a week at a time before returning it to its home base.

The interviewee evaluates the fleet annually to identify high-mileage trucks for retirement. The interviewee is the main decision maker but gets the company's president to sign off on decisions. Mileage is used as the primary metric for retiring vehicles. The company's Class 2 through Class 5 vehicles get the most miles and therefore have the most turnover. Meanwhile, their Class 8 vehicles do not get as much usage and may last as long as 20 years. Due to the pandemic-induced vehicle shortage, the company is holding on to high-mileage vehicles longer than it used to (up to 300k miles, versus 250-300k miles pre-pandemic). CARB emissions requirements also play a role in fleet turnover decisions. The interviewee aims to move two medium-duty vocational trucks to North Carolina by the end of the year as they do not meet CARB regulations. The interviewee receives regulation notices through a CARB email subscription.

Retired trucks are auctioned off, used as loaners when trucks are out for maintenance, or cannibalized for parts.

The company has previously bought used vehicles, but they are now exclusively leasing because lease payments don't impact the company's tax liabilities at the end of the year as much as purchasing does. The CEO prefers Fords, Peterbilts, and the occasional Freightliner. While the interviewee is not a fan of the Ford Class 2 to 6 trucks and would be interested in looking at other brands like GM, the CEO won't approve it. However, the interviewee noted that Peterbilt gets trucks back on the road quickly and that they can get convenient service at any Ford dealership nationwide. Minor maintenance is done all in-house, but for more involved work, like diagnosing problems, they go to the dealer.

One change the interviewee is initiating is switching from their current 6.7-liter diesel engines to newer 7.3-liter gasoline engines. A few vehicles have the 7.3L engine and have not been to the shop in a full year. If it continues to go well, the interviewee plans on making a pitch to the boss to switch to the newer engines. As far as fuel economy, there is no way to track it because many of the trucks use fuel transfer tanks to refuel in the field.

The boss is interested in Ford F-150 Lightnings due to fuel cost savings and the positive public image it engenders. The interviewee is not confident about EVs suiting their operations, citing that driving from Southern California to Sacramento would take two days. They believe it may be a couple of years until Ford Lightnings will be available for fleet leasing. The interviewee gets EV information primarily from online sources, as they haven't been to fleet shows recently due to COVID. When asked if electric trucks might be better suited (compared to diesel) for idling and running lights, the interviewee was concerned that running electricity off the truck would drain the battery and drivers would be unable to go home.

Interview Summary for Fleet Number: 43

1. **Region:** California
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 2 trucks
4. **Truck type(s):** Class 7
5. **Use-case(s):** Heavy Duty (Short haul, day truck); Medium-duty (Delivery)
6. **Buy or Lease:** Purchase
7. **Purchase condition:** Used
8. **AFVs:** None

<u>Keywords</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: Maintenance costs, parts availability, regulation compliance

How are they used: The factors of maintenance costs and parts availability have been used to inform the decision to stick to a preferred vehicle manufacturer (Freightliner) and the decision to purchase used vehicles. Ongoing vehicle inspections and regulatory updates from CARB drive the decision to retire trucks.

<u>Summary</u>
Fleet 43 is a hazardous waste transport company that operates primarily in California with limited out of state operations. The fleet consists of two trucks: one is used locally in Southern California and the other is used to go to Arizona once a month. The company hires subcontractors for other out of state work.

Interviewee 1 is the general office administrator, who facilitates equipment purchase and rental. Interviewee 2 is the company owner, who is the sole decision maker for purchasing and retiring trucks. As the company has grown, it has been purchasing increasingly larger box trucks, and is entertaining the idea of purchasing a trailer truck. They typically purchase used trucks from leasing/rental companies like Penske and Ryder. Freightliner has become a preferred make for the company due to the abundance of parts that makes repair easy and affordable. The interviewees get trustworthy vehicle information from fellow fleet operators and sales reps they have relationships with (e.g., Penske).

The decision to own and not lease comes is based on experience and the understanding that ownership is less costly for the company than lease payments. Interviewee 2 used to keep records to calculate cost per mile, but now goes by heuristics and just "knows it" based on experience. One example given was that if a subcontractor increased their prices, they see that as a signal of fuel and labor prices and adjust accordingly.

The interviewees indicated that they make retirement decisions primarily based on the maintenance costs that grow as vehicles age. The used vehicles they purchase are no longer covered by the manufacturer warranty, so they purchase an aftermarket extended warranty. Once trucks begin to be out of warranty, and major repairs crop up, they start looking at retiring the vehicles. They don't have a specific mileage threshold – rather, they look at out of service time and how trucks do on regular BIT inspections. BIT inspections are done every 90 days so drivers can identify red flags and repair needs which in turn inform retirement decisions.

In one case, two trucks were retired because they were going to be out of compliance with CARB clean air regulations. The interviewees noted that CARB gives them advance notice of new regulations and requirements, which allows them to budget for upgrades that meet new requirements. They receive news through a few publications, DOT contacts, and peers.

Retired trucks are resold online or through a broker, and the trucks usually go to other trucking companies.

When asked about electric trucks, they indicated that they applied to participate in a pilot study, but the status is still pending. The interviewees are receptive to electric trucks, particularly if there was a grant available to offset the costs. The cost calculations would be new territory for the company, requiring research through the Internet and through speaking with industry contacts.

Interview Summary for Fleet Number: 44

1. **Region:** National/Regional (Multi-state)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 650 Trucks
4. **Truck type(s):** Class 2b-8 (all classes)
5. **Use-case(s):** Heavy Duty (Long-haul, line haul), Medium Duty (Vocational with Power Take Off)
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** Both New and Used
8. **AFVs:** Hybrid

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: Turnover is determined by the balance of *residual vehicle value* and *maintenance costs*. *Fleet consistency* motivates the company to stick mainly with one brand. *Top-down interest in EVs* spurred the company to participate in a pilot program.

How are they used: Factors are analyzed using a data-driven, analytical approach to determine fleet purchase and turnover decisions, with input from branch fleet managers, the interviewee, and upper management/executives.

Summary
Fleet 44 is a landscaping company that operates approximately 650 trucks in California, Nevada, and Arizona. The interviewee is the director of fleet management and oversees fleet managers at each branch location. Fleet managers send quotes to the interviewee, who reviews and forwards them to the CEO. In the past, fleet managers selected vehicles and acquired quotes. However, with the vehicle shortage, it has become easier for the interviewee to take on orders. Now, they project further into the future (up to two years in advance) to give Ford early notice of their vehicle needs.

The company buys mostly new Fords, mostly light-duty trucks (F150s, F250s, F350s, etc.). The fleet includes tractor-trailers and even some specialty units like equipment haulers and large dump trucks. These specialty trucks are other brands, like Peterbilt or Kenworth. Fleet units are brought back to the yard, except for a few executive vehicles. They benchmark based on previous years' order prices. The interviewee is vigilant in keeping track of base costs, tax, and costs of specs to ensure that dealerships don't hide extra costs. While they avoid buying used, they do analyses on a case-by-case basis and may buy used if the value is there. The company has certain standardized specs for different needs (e.g., a spec for irrigation), which builds consistency for maintenance technicians. Having all Ford vehicles also helps with consistency. Drivers don't have much of a say, but this year the interviewee is implementing a survey to gather driver input on vehicles. Because of the truck shortage, the interviewee started working with leasing companies that will help them bridge the gap and get trucks while they wait for an increase in truck availability. With leased trucks, they don't get a choice of brand.

Currently, vehicles are “run into the ground”. The interviewee is moving towards keeping a newer fleet to boost employee morale and to present a better company image. The interviewee makes recommendations, but the individual fleet managers oversee vehicle cleanliness, age, and health. Branch fleet managers have freedom except for safety and regulatory compliance, which are enforced by the corporate office (the interviewee).

Over time, they have put more consideration on the “optimum disposal window” based on the purchase price, operation, and maintenance costs (akin to a TCO calculation). The window is usually between six and nine years. They are also reviewing fleet software that will assist with calculations at the fleet level. The interviewee wants to stay ahead of CARB regulations, avoiding a situation where they must retire a vehicle to comply with regulations.

Historically, the company has sold vehicles at auction. Recently, they have been working with companies that do direct sales and allow them to get the vehicles sold more quickly. They are looking into allowing internal sales to employees.

The company is running a pilot program for the Ford F150 Lightning (expecting vehicle delivery in October 2022). They are installing chargers at employees’ homes and tracking the trucks through telematics. Two “champions” were chosen among senior employees to participate. In return for participating, Ford is prioritizing the company’s future requests for more Ford Lightnings. This will enable them to run electric equipment such as electric lawn mowers. As a landscaping company, it also benefits them to have a greener image.

After a conversation among management about EVs, the interviewee then built a scorecard comparing different hybrid and battery electric vehicles, incorporating aspects such as range, safety, and maintenance costs. The Ford Lightning was well received by the executives. However, the interviewee was concerned about future charging needs (e.g., charging 180 trucks in one yard).

Interview Summary for Fleet Number: 45

1. **Largest region over which fleet is operated:** Local or regional within California: Los Angeles and San Francisco Bay Area
2. **Ownership Model:** Centrally owned, single owner
3. **Fleet size:** 12 trucks total; 5 Toyota (HINO) and 7 Isuzu. All are bobtail, or straight, box trucks. HINOs are 24 to 20 feet; Isuzus are 14 to 20 feet. Six run in northern California; six run in southern California.
4. **Truck class(es):** Class 5 and 6
5. **Use-case(s):** Medium-duty (PNP, regional, local, and last mile)
6. **Buy or Lease:**
7. **Acquire new, used, or trucks in both conditions**
8. **Hybrids or AFVs currently present:** No

<u>*Keywords*</u>
Decision Making Structure: Sole: *"…usually the decision is made by myself, with input from my dispatchers or managers of those particular locations. I'm the owner of the company, so I kind of make the decision on what's going to be bought, where, how what size and what needs to be gotten rid of."*
Adaptability: Not ascertained due to truncated interview.
Complexity: Not ascertained due to truncated interview.

Inputs to fleet turnover decision-making: truck application, truck availability for purchase, brand reputation (reliability and maintenance cost), and liability

Though a story is told by interviewee of an old International truck retired because of emissions, the fleet is generally new and emissions may not be a major factor. (HINOs are 2018 or newer; Isuzus, 2017 or newer.) The International was donated to an ex-employee. More important over the past few years is a shift in *application* from last-mile, business-to-consumer deliveries (predominately deliveries to residences) in smaller trucks (thus, the Isuzus) to predominately business-to-business deliveries. These entail LTL shipments and require/allow bigger trucks (thus the HINOs). He describes the box truck market as dominated by three manufacturers, so *availability* proscribes his choices to a small set. Choice of HINO from this set is based on the fact they are Toyotas; he regards them as having a *reputation* for *reliability* and low *maintenance cost*. Related to maintenance cost and the necessity to keep at least the basic, legally required records of maintenance, he notes the importance of *liability*: "When you have a fleet, you're a business owner who cares about liability more than anything else because you're exposed to liability as a business owner. So, keeping your trucks maintain[ed] is a vital part of that."

How are these inputs used? As sole decision maker, he acknowledges input from his dispatchers and his southern and northern California site supervisors. He describes that as a small company, he is not devoting resources to "track costs down to the penny." Though we don't get a far as confirming how he makes truck acquisition and retirement decisions, he provides the impression it is a bit, "seat of the pants," i.e., based on his experience rather data-driven analysis of ongoing costs or projections:

"I don't have an analyst analyzing everything and I'm not much of an analyst….I'm not analyzing my fuel records all the time and maintenance records so it's kind of down in my head. I remember my costs on my Internationals, and I remember my costs on my HINOs, and I remember through maintenance through the years of what cost me more what didn't cost me more. [Therefore] just through experience I choose [the] brand. And it's, not only because of the truck brand it's also because of the vehicle brand as well as life experience I had from driving [these] my whole life."

Interview Summary for Fleet Number: 46

1. **Region:** Local (Nevada, California)
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 5 trucks
4. **Truck type(s):** 26-foot box trucks
5. **Use-case(s):** Moving company
6. **Buy or Lease:** Buy and lease (preference now is to lease, given supply chain and high new/used truck prices)
7. **Purchase condition:** Used
8. **AFVs:** N/A

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The fleet owner mostly uses his judgment about the costs to repair vs. the cost to acquire new or used trucks. In the current market (year-plus wait for new trucks; very high used truck costs), the owner does everything to keep his current fleet on the road as long as possible. Major structural repairs for the box or chassis will likely signal the need for acquiring a truck.

How are they used: The owner will avoid a vehicle acquisition unless he's facing major repair costs and/or long downtime on a truck repair.

<u>*Summary*</u>
Fleet 46 primarily provides local moving services in Nevada, and they also operate in California about once a week. The 5-truck fleet consists of exclusively Class 6 26-foot box trucks. The owner only uses up to 25,999 GWVR trucks so that his drivers don't need commercial driver's licenses, which add several other complications (e.g., electronic hours-of-service logging).

With the pandemic leading to major supply chain interruptions and significant delays on new vehicle deliveries, as well as skyrocketing used vehicle prices, Fleet 46 aims to squeeze every bit of life out of their trucks. Thus, the truck replacement calculus has changed quite a bit over the past 2 years. For example, in 2018-19, Fleet 46 could acquire used trucks for $20-25K, but now used truck prices are ~ $75K. They recently had to do an engine replacement for $17K, and the owner expects the truck to last another 7-10 years with that rebuilt motor. With used truck prices so high, the decision to do the engine replacement was easy. However, two years ago, with used trucks costing $20-25K, their decision would have been to acquire a used truck.

Fleet 46 pays cash for all vehicle acquisitions (i.e., no financing). Given the current supply chain situation (12-16 month wait for new truck deliveries) and the very high cost for used trucks, they have one leased truck. At the end of this lease, they will own the truck. In addition, maintenance is included with the lease payment.

They're spending roughly $8-10K per truck per year on maintenance. On principle, Fleet 46 is going to drive their model year 2002-2009 trucks "into the ground." These trucks are paid for and provide great value, so the owner has no incentive to sell these, even though he would get a very nice price for the highly coveted trucks. This is possible because they're primarily doing local service. If it were mostly long-haul, he would need newer trucks.

A truck being out of commission for a long stretch is very big to their company. Each truck pulls in about $1,500 in revenue every day (working 6 days/week). Perhaps more critically to the company, each truck supports 3 workers, who will leave if there isn't enough work. This is compounded by the fact that it's very hard to find quality workers in the current market. The owner believes in treating his workers well and focuses on building relationships. As such, his turnover rate is very low compared to previous ownership of the company.

With the current market situation, acquiring trucks via a lease makes the most financial sense, given that maintenance is included, and they get a replacement truck right away if the truck goes down for long-term repair.

Fleet 46 has 3 International trucks and two Hinos. According to the owner, Peterbilts are good trucks but roughly 2,000 pounds heavier, so they avoid this brand. Hinos are good trucks, but keeping them maintained is more difficult, given lack of parts and technicians in the Reno area.

Major barriers for this fleet to electrification are: 1) capital costs, 2) lack of local maintenance network, 3) charging unknowns at the depot and out in the field. The owner's sentiment is to let the larger fleets prove out the ZEV technology first.

Interview Summary for Fleet Number: 47

1. **Region:** National
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 11 Trucks
4. **Truck type(s):** Class 6
5. **Use-case(s):** Medium-duty
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<ins>*Keywords*</ins>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Continued operation* is the most critical input, even taking precedence over factors like CARB compliance. *Brand loyalty* to Japanese makers stems from experiencing *low maintenance costs. Reliability* is top of mind for out-of-state operations.

How are they used: Preference is given to Japanese makes when purchasing used trucks. For these used trucks, the company drives them for as long as possible, even beyond CARB compliance. For longer routes, the need for new, reliable vehicles has led to the leasing of newer trucks.

<ins>*Summary*</ins>
Fleet 47 is a moving company based in San Diego that operates in several states, including California, Arizona, and Florida. The interviewee is the company's owner.

Initially, the interviewee purchased used trucks directly from truck dealers. As the company expanded to out-of-state operations in 2020, it sought newer, more reliable trucks and shifted to leasing from companies like Penske, Ryder, and Enterprise. These trucks are under a five-to-seven-year lease. The remaining used trucks are around 15 years old. For local jobs, trucks average 72 miles per day.

The interviewee prefers Japanese trucks such as Hinos, Mitsubishi, and Isuzu because they last "forever" and have few problems. They have had a good experience with Mitsubishi trucks (e.g., driving for 7-8 years without an issue). They may be more expensive but require less maintenance. The interviewee bases this on experience and does not perform calculations or record keeping of costs.

While they can't ask for specific brands from the leasing companies, they can choose other specs. They make sure to get a box big enough to fit enough furniture for a four-bedroom home, with at least one side door, a lift gate, and a ramp. They ensure trucks are less than 26,000 pounds to avoid requiring drivers to have CDLs. Ten thousand pounds are usually reserved for furniture.

A third-party mechanic performs maintenance of used trucks that they call every two to three months. Preventative maintenance (e.g., oil changes) is done more regularly (every 2,000 miles) to avoid having to call a mechanic in. Leased trucks don't have the option to do accelerated preventative maintenance like that.

The owner used to make all fleet decisions but 8-9 months ago, they started using a subcontractor who now leads the decision-making for purchasing and leasing trucks. The driving motivation for subcontracting the work was that the interviewee no longer wanted to deal with employees. Recruiting and retaining drivers is hard, and employees are unreliable. That said, drivers appreciate driving the newer leased trucks, mainly because the AC is working.

The interviewee gains information from others in the industry like mechanics, owners of moving companies, and employees. Sometimes, leasing companies reach out, and the company tries out new things.

For the owned trucks, they are used until they don't work anymore, at which point they are sold on Craigslist for a few thousand dollars. The trucks typically go to South America, where they are fixed up and used. The interviewee keeps older trucks that still work for storing equipment or boxes, or as replacement trucks when others are in repair. Some older trucks do not comply with CARB regulations and can't get registered. However, because they are the "core" of the freight, they can't afford to take them out of service and drive them anyways. The interviewee noted that the risk of a $300 fine is worth it when renting a truck for a day costs $400.

Interview Summary for Fleet Number: 48

1. **Region:** California (parent company is based in Ohio)
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 8 Trucks, 40 other company vehicles
4. **Truck type(s):** Class 2b and Class 3
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Lease only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Total mileage* is the main factor that determines when the company turns over vehicle leases. *Brand loyalty* to American manufacturers impacts vehicle choice; for delivery trucks, *reliability* and *available cubic feet* are also important. Having identical vehicles within the fleet provides *brand recognition* to the company.

How are they used: These inputs are evaluated quarterly to decide which leases to turn over and which new vehicles to acquire. The interviewee is the sole decision-maker, although they need to update the boss and submit capital expense reports to the parent company.

<u>*Summary*</u>
Fleet 48 is a licensed Xerox resell agency that operates 48 vehicles in total, 8 of which are medium-duty trucks. The company fleet serves as delivery vehicles and general company vehicles and therefore spans delivery vans, box trucks, sedans, and luxury vehicles for executives. All delivery drivers and most service technicians are assigned company vehicles. Sales managers and above are also offered vehicles. For some employees, company vehicles are available for $100/month as part of their compensation package.
The company used to have many extra vehicles but when COVID hit, they got rid of the older vehicles and are now holding on to vehicles for longer. Whereas before they started considering turning over the lease at 100k miles but are now looking at 150k to 200k miles. Vehicle needs are assessed about every quarter to see if new vehicles need to be leased or old ones turned over.

They partner with Enterprise, which manages the lease program and provides a maintenance program with preferred repair vendors. They pay out of pocket for large repairs (over $750) but pay pre-negotiated rates thanks to the maintenance program. After a lease ends, Enterprise puts the vehicle up for auction on behalf of the company. Drivers get WEX fuel cards (WEX is a financial service for fleet fueling) that allow the company to track fuel spending at gas stations. Enterprise has an online platform where the interviewee can manage WEX cards and all other Enterprise services. The platform also includes all the metrics used by the interviewee – they don't do any other accounting or tracking of metrics like TCO.

The interviewee's boss insists on having American-made vehicles, which is why they mostly have Ford vehicles. Within each group of employees, they keep the fleet uniform to avoid differential treatment (e.g., all salespeople get white Ford Fusions). That said, the company has switched its box trucks to Isuzus for their reliability and greater transport volume. For delivery vehicles, operational needs trump the country of origin. Decisions are discussed with the boss, but it is more of a check-in than an approval. The parent company is also hands-off, only requiring a regular capital expenditure report.

In some cases, the interviewee prefers it when deliveries are made with sprinter vans rather than with big box trucks. This is convenient when they are only delivering a few copiers, and it avoids having to go through truck scales. An additional advantage of delivering via sprinter van is that drivers are exempt from DOT standards such as drug testing requirements. For example, an employee that is legally using marijuana in California may test positive and be in violation of DOT regulations. Such a driver can be moved over to a sprinter van, providing flexibility for the company. Sprinters can also be outfitted with lift gates, which allows drivers to load equipment alone with ease. This year, the company switched all its sprinters to diesel due to drivers mixing up diesel and gas vehicles and filling them up with the wrong fuel.
The main concern for AFVs is the location of charging stations. The delivery trucks return to their warehouse every night, so they could install chargers there. However, the rest of the fleet goes home with their respective employees. This complicates how they would get charged, particularly for employees that live in apartments/condos.

Interview Summary for Fleet Number: 49

1. **Largest region over which fleet is operated:** Multi-state across U.S., throughout CA but primarily L.A. area, and parts of Canada
2. **Ownership Model:** Centrally owned.
3. **Fleet size:** 3 box trucks (< 26K lbs., maybe Class 5-6). Class 8 forthcoming
4. **Truck class(es):** Maybe Class 5-6; Class 8 forthcoming
5. **Use Cases:** Medium-duty delivery (but long-distance delivery)
6. **Buy or Lease:** 2 trucks owned (1 purchased, 1 financed). 1 truck rented.
7. **Acquire new, used, or trucks in both conditions**: Buy used, rented new
8. **Hybrids or AFVs currently present:** No

<u>Keywords</u>
Decision Making Structure: Egalitarian. All 3 owners have equal say but finding a candidate truck falls under interviewee's purview.
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making
Immediate and near-term demand is the primary purchase driver. A lack of cash and credit (necessary for financing and leasing) are the primary restrictions. 49 currently rents a truck but would prefer to lease or own because it is cheaper. However, Fleet 49 did not have funds to purchase a new truck and did not qualify for a lease because they have not been in business long enough (<2 years) to have the credit rating for those options. Likewise, they like the idea of extended warranties but can't afford them. Still, maintenance/repair costs are important, so they prefer to buy from Penske who fixes most issues before selling used trucks. Similarly, they feel single truck owners take better care of trucks and, so, prefer to buy from them rather than big fleets. They don't worry about ARB regulations because they believe they are too small to be affected. Fleet 49 has only a rudimentary understanding of their operating costs and recording keeping is scarce and applies only to some out-of-pocket expenses. All 3 owners have input into every truck purchase. Fleet 49 hopes to buy 100 trucks in the next 10 years but currently operating costs are exceeding revenue.

How are these inputs used?
Fleet did find a new truck for a relatively small upfront payment. Shortly after they hope to have enough credit to lease, which they will consider because of increasing demand. They have very little experience with truck purchase and search primarily through online sites and social media. They evaluate truck cost and life-expectancy by looking for a mileage sweet spot. They prefer to buy a truck after the engine rebuild and other problems have been discovered and fixed. This allows them to buy high-mileage inexpensive trucks without too much maintenance and then sell them while the trucks still have some value. There seems to be little consistency among truck acquisitions and judgment guides the process rather than data.

<u>Summary</u>
The interviewee is one of three owners, all drivers, of a small general freight transport company (all types of cargo) that operates throughout the U.S. and parts of Canada. They are based in

Arizona but much of their operations are in California. They use the fleet primarily for long-haul delivery service. Fleet 49 has three < 26K box trucks and a Class 8 truck that is expected to be purchased in a few weeks. The interviewee is in the process of obtaining a CDL license to drive the new semi-truck. Two of their trucks were financed and the third is a rental. They rented for ease of expansion and to avoid a large upfront purchase cost. Also, they rent because they have not been in business long enough to have the necessary credit for purchasing. The rental is more expensive, but they made an analogy to a boat with a hole but instead of a bucket to bale the water, all they have is a cup until they can get to land. All three owners form a decision team regarding fleet purchases but the interviewee, who oversees all "operational things", is the one tasked with finding fleet trucks.

Their used semi-truck selection strategy (ongoing) is to purchase a truck with very low mileage (< 50K miles) or one with 400K-600K miles. The latter mileage target is based on their observation that most problems happen in the first 500K miles and the engine is usually overhauled about that time. Therefore, they can get a post overhauled truck with most of the operating issues having already been addressed. They can then sell the vehicle after its service life to the final owner for $25K-$30K. They are looking at a 2014-2016 Freightliner because that brand has performed much better than other OEM trucks in their fleet and it is within their purchase price budget (although they are aware that newer trucks get much better gas mileage).

Medium size box truck selection is a little different since they are only expected to last 600K-700K miles. The box trucks are used for deliveries which involve more stop and go driving, so they wear faster. They bought their last box truck from Penske at about 265K miles and don't plan an engine overhaul. The plan to scrap it at the end of service.

The interviewee felt that warranties were "lifesavers" but admitted that they do not buy extended warranties. They did not have the cash available for a warranty but felt that faithful maintenance could eliminate much of the need. Also, Penske does a thorough check and conducts necessary repairs before selling their vehicles.

For the upcoming Class 8 purchase they hope to buy from an owner-operator because Fleet 49 feels they take better care of their trucks opposed to a fleet that has many vehicles to maintain. They are searching for the truck using Craigslist, Google, and Facebook. However, they may also buy from a dealership with financing, in which case they would try to have a warranty included in the deal. They cannot lease as of right now because the business is new and does not have 2 years of tax returns. They will meet this requirement in a few months and may lease a vehicle, in addition to the one being purchased, because the business is growing. His goal is to have 100 trucks in the next 10 years.

Operating costs are not yet fully understood because business is new. They know approximately the cost per mile and cost per day. However, calculations are for out-of-pocket expenses and do not include maintenance, driver, depreciation, etc. Even these cost estimates are very "rudimentary". For the first half of this year, operating costs exceed revenue by about $53K, which includes $40K for truck purchases. They use a software called Motive to keep track of fuel economy across all drivers and trucks. Most of their Phoenix base operations send trucks into Southern California for loads but they try to avoid buying petroleum in California because of the higher prices.

They do not worry about CARB regulations because they feel they are too small to be affected and any forthcoming regulations are in the distant future. Although, they have one pre-DEF truck in their fleet that the interviewee believes may be restricted in California (interviewee is unsure). They do not use that truck in California. Alternative fuels won't work for them because of fuel availability. They drive long distances and often cities are far and few between (especially in Canada).

Fleet 49 plans to run their trucks "into the ground" and then send them to the junkyard or scrap it for cash. Most of what they know about trucks and the trucking industry they learned through trial and error, through peers and friends, from a particular dispatcher, and through previous experiences driving for another company for about a month.

Interview Summary for Fleet Number: 50

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 5 Trucks
4. **Truck type(s):** Class 6
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Used only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Vehicle age* is the main factor driving fleet acquisition decisions and is linked to *fuel economy* and *reliability*, whereas issues with *vehicle failure/maintenance* are key for retirement considerations. *Word of mouth* is important for choosing brands. *Driver feedback* is considered for truck purchases.

How are they used: Decisions are made with input from the interviewee, their husband, and drivers. As a new small business, they tend to make decisions on a case-by-case basis based on economic viability. Company practices such as purchasing only Freightliner trucks come from experience.

<u>*Summary*</u>
Fleet 50 is a small business that delivers general freight (dry goods only) within the contiguous 48 states. The interviewee is the company owner. They operate five 26-foot box trucks.
The company purchases all trucks used. At the start of the business in 2019, they were not eligible to lease and had to rent. They tried renting from Ryder but had a bad experience due to poor communication, a long wait time, and the truck not meeting expectations. Afterward, they resolved to only purchase trucks.

The current fleet is composed of trucks from the model year 2012 to 2015 and bought from a mix of dealers, other businesses, and leasing companies. They tend to buy trucks no older than 7-8 years old. The company chose 26-foot trucks to carry the largest loads without requiring commercial driver licenses. They would consider getting a 53-footer (Class 8 tractor-trailer) with a bed to make drivers comfortable for multi-day drives. As they are still new to the business, the interviewee would like to lease a 53-footer for a trial run but would like to purchase one in the long term, money-permitting. As for other specs, the interviewee has had issues with laws being different between states (e.g., only some states require truck skirts, chains, etc.).

Purchase factors include cost, reliability, and fuel economy. The interviewee's husband and company drivers help evaluate trucks (comfort, longevity). The husband's experience with Freightliners influenced them to stay with them as a brand. Similarly, they take input from friends within the industry. Purchases also depend on what the company's trucking demands are: they may feel desperate if they lose one of their trucks and need a replacement right away. With high prices and economic uncertainty, the interviewee would not expand the fleet. They also don't want to sell any trucks, as the current high prices are not worth the lost revenues. They don't have experience with disposing of trucks yet. One truck was having issues and was almost retired, but someone figured out what was wrong with the truck. They hire a third party for maintenance.

The company has trouble with having consistent driver availability. They recruit drivers through trucking company groups and referrals from other drivers. Drivers must pass the DOT physical and use the ELD to log driving hours. The interviewee expressed concerns about drivers sitting idle due to canceled loads, while the ELD is still counting. Drivers can also be stressed when trucks are out of service. Unexpectedly, COVID made it easier for the company to find drivers as there were more people looking for jobs.

The interviewee tracks loads, payments, fuel costs, etc. in a spreadsheet. With the high gas prices, the company is passing on those costs to its customers.

The interviewee is open to change regarding emissions regulations and alternative fuels but will wait until they must address them.

Interview Summary for Fleet Number: 51

1. **Region:** California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 12 Trucks, 5 Vans
4. **Truck type(s):** Class 2b, 4, and 6
5. **Use-case(s):** Heavy Duty (Short haul, day truck), Medium-duty (Delivery)
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** Both New and Used
8. **AFVs:** Hybrid

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Growing delivery needs* and *vehicle reliability* are key factors for purchasing, while *vehicle age* and *maintenance costs* drive fleet turnover. The company has built *brand loyalty* with Hino for its box trucks.

How are they used: Decisions are made iteratively and with approval by the company's owners. They try out different setups (e.g., diesel Ford Transits) and react to conditions (e.g., costly DEF maintenance, CARB compliance).

Summary
Fleet 51 delivers fleets to large restaurants and catering companies with its fleet of approximately 17 refrigerated trucks and vans. The interviewee is the purchasing manager and is responsible for fleet purchasing decisions, although the owners need to approve. The interviewee uses a fleet management software called Samsara that tracks temperature control, fuel levels, diesel emission filter (DEF) fluid, GPS, etc.

The fleet used to be composed of used Ford Transit and Econoline gas-powered vans. Over time, they have moved from a van fleet to more of a truck fleet to haul more products. The interviewee doesn't want to go bigger than Class 6 because they're already having to avoid certain streets in LA that have a vehicle weight limit, hence their Class 6 refrigerated box trucks. The fleet experimented with diesel-powered Ford Transits because diesel vehicles run for longer, and diesel was cheap at the time. However, they had issues with constant repairs and recalls, and had trouble passing smog tests. It was also unclear which repairs were covered under the Ford warranty.

For their box trucks, they tried long-term rentals of Hino trucks, and they worked well for the company. They also enjoyed the flexibility of being able to replace the engine separately from the box. They have also built a good relationship with the dealership. Eventually, the interviewee switched to the Hino 195h model with a hybrid engine. They were able to buy five or six Hino trucks at a time thanks to a California rebate program. The fleet's Hino trucks have 7-year warranties.

They have two trucks that they purchased used and are now needing costly repairs, particularly for DEF components. The same issue comes up for the diesel Ford Transit vans, but not the newer Hino trucks. The interviewee sometimes finds their vehicles don't comply and often must make adjustments within 30 days, which is difficult to achieve. They have a hard time navigating the CARB system, so they don't find out until getting cited. When they retire vehicles, they sell them in the used market for a small sum (no more than $1,500). Vehicles stay in their fleet for about 4 to 5 years and are retired when they start costing more (in maintenance) than they're worth.

Due to the truck shortage, have taken on three long-term rentals with Enterprise. They are also having to hold on to older vehicles and "put band-aids" on them to keep them running. Ideally, the interviewee would love to pull four of their vehicles off the road. It has also been difficult to find drivers since the start of the pandemic. To communicate with other employees, drivers must be fluent in Spanish.

Electric vehicles are out of the question because their trucks move 12-13 hours a day and don't have time to charge them. Natural gas is a possibility if there are stations. They have a mechanic that they work with (not in-house) who may not appreciate having to work on a new type of vehicle.

Interview Summary for Fleet Number: 52

1. **Largest region over which fleet is operated:** National (Heavy-duty trucks haul nationally; medium-duty are local-regional around hubs)
2. **Ownership Model:** Mixed
3. **Fleet size:** 800 to 1,000. 650 Medium-duty straight trucks with lift gates and 150 heavy-duty tractor-trailers.
4. **Truck class(es):** Class 6 and Class 8
5. **Use-case(s):** Heavy Duty long-haul, short-haul, Medium-duty
6. **Buy or Lease:** Lease (and rent) only
7. **Acquire new, used, or trucks in both conditions:** New only
8. **Hybrids or AFVs currently present:** No

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making: Lease terms. Demands from the third-party logistics company with whom Fleet 52 contracts. Short-term fluctuations dealt with via truck rentals lasting from a week to several months. COVID-induced supply chain limits on truck availability: lead time for new trucks to be built.

How are these inputs used? Interesting description of a business in which no principal actor owns the means of production. Fleet 52 identifies itself as a dedicated carrier partner (DCP) and appears to contract solely with a single third-party logistics firm. The logistics firm identifies freight loads it does not own and contracts Fleet 52—which does not own any of its trucks—to deliver those loads. Deliveries are "unattended" afterhours to businesses. *Leasing* is presented by Fleet 52 as a means to control costs and renting as a means to fill short-term demand presented to it by the logistics firm.

Summary
Fleet 52 provides business-to-business deliveries arranged by a third-party logistics company. It is inferred from the interviewee's discussion of specific routes that many of these deliveries are of a long-standing nature. 52 primarily uses Class 8 trucks to transport loads from a supplier to a regional hub operated by 52, though deliveries to some ultimate buyers may also be made in Class 8 trucks. In general, though, Class 6 trucks transfer loads from hubs to ultimate buyers. Longer version of the argument that leasing is a means to control cost:

> *"Basically, it's like there's so many different costs … involved and I'm not … an expert. … it's based on …the cost of … services and … repairs…The two biggest costs [are] labor and … equipment. So, all these things you're going to want to have your trucks: you got to get tires, you got to get services, gotta get repair. So, it's more cost effective to have a lease … maintenance, full-service maintenance… it's like getting a car warranty. For your car, you pay your car payment plus extra, whatever, 50 or hundred dollars for your warranty in case*

anything breaks down. So, when these trucks break down or need tires or whatever, it's included in what we're already paying. You don't have …this asset that you now have to pay [for repairs] on top of what you already paid to have it and hope that it doesn't depreciate. Then one day, you can give [the truck] back, quote unquote give it back, to Ryder or wherever you rent it from or lease it from … Sometimes they'll give you credit if you didn't drive it as much miles, as you were, as it was [estimated to drive at the time the truck was first leased], or if there's not as much wear and tear or what have you."

Leasing companies Ryder and Penske are discussed throughout the interview, generally in terms of willing suppliers of trucks that Fleet 52 wishes to operate. Decisions between Ryder, Penske, or any other leasing company are described in terms of regional differences in coverage and availability. The leasing company located nearest one of Fleet 52's hubs is likely to be chosen for its convenience. Fleet 52 professes no loyalty to any leasing company or any truck brand.

The third-party logistics company may present Fleet 52 with jobs that require quickly acquiring new trucks; these situations may be handled via truck rentals with shorter terms than truck leases.

"So, we … agreed upon … a monthly like flat fee that we pay to lease a truck or rent a truck. And then whatever miles that we drive that truck we also have to pay for. So, like either the miles are estimated … like Ryder will estimate that we're going to use, or we tell them we're going to use this truck on this certain route for five years. And then they're going to … charge you based on that as an estimate for each week or each month. … It's like there's no set limit. Just because a truck has 500,000 miles on it doesn't mean that you can't use it anymore. But sometimes there's limits on like a truck, like when it gets to a certain life of the truck that's estimated that I won't, shouldn't be driving every day anymore, or [it] could cause a lot of like issues. Then we go and we get rid of that truck, and we lease or rent new truck or a new or newer … yeah."

Interview Summary for Fleet Number: 53

1. **Region:** National
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** Over 200 Trucks
4. **Truck type(s):** Class 8 (sleeper trucks)
5. **Use-case(s):** Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** New only
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Brand loyalty* is tied to *maintenance costs* and *ease of repair*, as sticking to one brand allows for uniformity and familiarity across the whole fleet. *Total mileage* is the main metric for determining fleet turnover. *Freight demand* was also a key factor for spurring the company to take on rentals, and then leases.

How are they used: The interviewee makes decisions with approval and in collaboration with their boss. They talk through all the different costs and benefits and make fleet decisions together, particularly with truck specs.

Summary
Fleet 53 is a long-haul carrier that does general freight and hazmat loads. The interviewee is the fleet manager for the company and manages around 200 trucks, 40 of which are leased and the rest owned. The owned trucks are Kenworth, while the other 40 are Freightliner Cascadias on 5-year leases from Penske.

The Kenworths are purchased with 40-year, 500,000-mile warranties. Once trucks get close to that, they start looking into retiring. One option is to sell to the company's contracted owner-operators (1099 workers). About 30 units are owner-operators with their own units, and about 15 more who became owner-operators by buying a truck from the company. Trucks brought in by owner-operators must meet inspection standards, including having a DPF (diesel particulate filter) for California operations.

They used to buy used trucks, but the cost of repairs was too high. Now they only buy Kenworths. Sticking to the same brand affords predictability and familiarity with everything that can go wrong with that brand. The interviewee oversees the company repair shop and says that when a driver calls in, they quickly have an idea of the type of repair and how long it will take. The company repair shop does all preventative maintenance in-house as it is cheaper and faster. Preventative maintenance is performed every 25,000 miles; more detailed service is done every 100,000 miles. For breakdowns, most repairs are done at Kenworth dealerships. The company doesn’t touch anything warrantied, like engines. Every truck in their fleet is covered under a warranty, including extended warranties for older trucks.

When the company needed extra coverage, they went to Penske to rent trucks. Over time, they built a relationship and found that leasing was a better deal than renting. Their leased trucks are Freightliner Cascadias because those are what Penske have available. Their first set of 20 trucks was leased about 3 years ago, followed by another 20 last year.

For both purchased and leased trucks, driver input gets considered in the specs (e.g., inverters and outlets for lights and a fridge). Specs are developed in discussion with the owner, and they follow a trial-and-error procedure by trying out different specs like transmission type.

The company did not face as significant supply chain issues as other companies, because when COVID hit, they kept their truck orders whereas other companies canceled them. However, they did run into a trailer shortage and converted some of those rentals to leases.

Interview Summary for Fleet Number: 54

1. **Region:** Northern California
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 25 trucks
4. **Truck type(s):** Class 2b, 3, 8
5. **Use-case(s):** Vocational
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New or used
8. **AFVs:** None, interested in electric

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Mixed
Complexity: Simple

Inputs to fleet turnover decision-making: For the semi-truck, they look at *upfront costs, driver satisfaction, and trustworthiness of the brand,* which they felt would help with ensuring parts availability. For the medium-duty vehicles, they consider the *model, age, and equipment setup* of the trucks (i.e., whether they are configured to meet the company's construction needs). They note that these trucks are strictly utilitarian and don't have "fancy bells and whistles". Driver input is not used as a purchase factor for the fleet's medium-duty trucks.

How are these inputs used: The interviewee is the Vice President of the company and works with his father (the owner of the company) to decide which trucks to purchase. There is a strong difference in the purchase considerations of their heavy-duty and their medium-duty trucks.

<u>*Summary*</u>
Fleet 54 is a construction company operating Class 2b and 3 trucks in pipeline construction applications and uses one Class 8 semi-truck to move their equipment or materials (e.g., quarry rock). Their medium-duty trucks include two bobtail dump trucks, five-yard dumps, and approximately 15 pickup trucks (F150-F550).

The interviewee is the Vice President of the company, which is owned by his father. The interviewee and his father work together to make truck acquisition and retirement decisions. The company has an in-house maintenance department who deals with routine maintenance of the trucks (e.g., oil changes, filter changes, brake maintenance, etc.), however, they outsource major repair work to the dealerships.

Under routine purchase conditions, they primarily purchase used trucks from other fleets. There have been occasions where trucks they were operating (one semi-truck and three pickup trucks) were no longer in compliance with CARB regulations, leading them to purchase new trucks from dealerships.

When making the decision on which semi-truck to purchase, they considered all different brands, and ended up choosing Kenworth because of the lower upfront cost, the preference of the driver, and because they trusted the brand because it had been around so long. They felt like it would be easier to get parts from Kenworth than other trucks that are not “brand name” or who have not been around for long, however, they would not necessarily purchase the same brand again, but would consider purchasing from any brand. For their routine medium-duty truck purchases, the interviewee looks online and at used car dealerships to compare the year and model of the trucks. They consider whether the truck is already set up for their application including having a utility box setup. These trucks are strictly utilitarian and don’t contain any “fancy bells and whistles”. Driver input is not used as a purchase factor for the fleet’s medium-duty trucks because the employees are not strictly truck drivers, they just use the trucks to move equipment and get to their job sites.

Fleet 54 typically runs their trucks until they are no longer operable due to regulations or when the cost to repair them is too high. They purchase used trucks and keep them well maintained for as long as they can before scrapping them. They have occasionally sold one of their trucks to “a homeowner or just a personal guy”, but there is generally very little value left to the trucks when they are done with them, so they are more commonly scrapped. When Fleet 54 retired the trucks due to CARB regulations, they were sold to fleets in Colorado and Oregon. Fleet 54 did not believe they were able to sell the trucks for the full value they were worth, but that they had to accept the offer anyways since they were no longer able to use them in their own operations.

With recent supply chain shortages caused by COVID, the interviewee notes that there are very few trucks at the used car lot and many of them are missing features.

> *“For instance, like heated seats and things like that, the truck is plumed for and wired for that, but the actual chip to run those darn things are not even available, and they can't tell you when, so when you buy the truck, they will say, ‘I owe you this switch, or whatever it is, that is going to make the heated seats work,’ but you're buying it without it at this moment, and they can't tell you when it's coming.”*

These complications have led the interviewee to postpone purchasing trucks until, “things kind of come back around, you know, quit being so weird and screwy.”

The interviewee is interested in electric vehicles, which is partially motivated by the high cost of gasoline and diesel. If they were to acquire an electric vehicle, the fleet would consider leasing which would allow them to, “try it out and see how we like it.” There may be issues with the high upfront cost of the truck, limited battery life, and with charging the trucks given that some of their employees take the vehicles home at night and don’t have charging stations installed at their houses.

Interview Summary for Fleet Number: 55

1. **Region:** National
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 15-17 Trucks
4. **Truck type(s):** Class 3-6
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Lease
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: Maintenance costs, regulations, driver safety, operational needs

How are they used: The interviewee chose to lease trucks to outsource maintenance, recordkeeping, and emissions compliance to the leasing company. Short lease terms (five to seven years) allow the interviewee to always keep a new fleet which avoids breakdowns, increases driver safety, and allows the quick transition to trucks of a particular specification.

<u>*Summary*</u>
Fleet 55 is a manufacturer of Asian/Filipino frozen foods that performs last-mile, local, and regional delivery in California and Hawaii. The fleet consists of 15-17 refrigerated box trucks (14-26 ft) leased from Ryder. The interviewee manages fleet acquisition and operations.

When the interviewee joined the company, the old trucks were all company owned. The interviewee switched to leasing trucks from Ryder to save maintenance costs, avoid recordkeeping required by the DOT, and to maintain a newer fleet that is both safer for drivers and complies with California air emissions standards. A vice president from a previous job recommended Ryder and the interviewee chose to work with them because they were the most cost effective. Ryder takes care of maintenance and DOT recordkeeping, which would be challenging for the company to do in-house due to its small size. The company hires a separate third-party that refuels the fleet nightly.

Leases are five to seven years long, allowing the interviewee to make relatively quick transitions to acquisition decisions that suit the fleet's operational needs. The interviewee notes that two leased trucks have swing doors and he is working to switch them out in favor of roll-up doors as swing doors have more pinch points and are hard to hold in high winds. There was an incident where a door hit an employee in the head. The interviewee has also transitioned all trucks to be at a standard height (40-52 inches) suitable for a dock leveler.

While the interviewee is the primary decision maker regarding fleet turnover, the interviewee prefers getting buy-in from upper executives and other departments like Finance and Sales. The interviewee advises the company owner's sons, one of which is the interviewee's direct boss. Fleet acquisition decisions must correspond with the products distributed by the company: for example, distributing both dry and frozen goods would require bulkheads that separate dry storage from cold storage within the same truck.

Going all-electric is a long-term goal for the interviewee and the company executives, and they want to be early adopters, but would prefer for someone else to work through the growing pains before making the shift. The decision to switch to electric trucks would be based on the interviewee's key performance indicators, such as cost per case and sales per usage hours. If the numbers made economic sense, the interviewee would be happy to make the switch even if it required changing routing.

Interview Summary for Fleet Number: 56

Region: National

1. **Ownership Model:** Centrally Owned
2. **Fleet size:** 24 Trucks
3. **Truck type(s):** Class 8
4. **Use-case(s):** Heavy Duty (Short-haul, day truck)
5. **Buy or Lease:** Both Purchase and Lease
6. **Purchase condition:** Both New and Used
7. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Maintenance costs* are the main driver for fleet turnover. *Demand for drayage* influences how many trucks are kept in the fleet. *Client preferences* for green fleets provide some direction but are usually moot for leased vehicles.

How are they used: The interviewee tracks costs and keeps tabs on the level of maintenance required for their trucks. The quantity of trucks is discussed with the company's chief operating officer (COO), while more granular fleet decisions are solely determined by the interviewee.

Summary
Fleet 56 operates drayage at the Port of Oakland, CA and Port of Savannah, GA looking to expand to Houston/Dallas, TX. They do local and regional carries. For the most part, their trucks have a chassis carrying a container; very few have tractor-trailer setups. The interviewee is the managing director and plans the company's workflow regarding vehicles, leasing, and maintenance.

In California, trucks are leased through Penske (5-year leases) and usually turned over for new leases. The leased trucks must stay within a certain mileage limit, so the company tracks what the trucks have done over the past few years and projects their mileage based on their regular routes. They chose Penske because it was the best deal cost-wise, and they also provide good service. Their trucks in California must go through inspection at the Cordelia scale house, and they've found that inspection goes more smoothly when driving leased trucks as the inspectors know that they are regularly serviced. The newer leased trucks are also more fuel efficient, which helps them to stay within California's emissions regulations – this is less of a concern in Georgia. The interviewee stays up to date with CARB regulations and ensures that their trucks have stickers indicating CARB compliance for port operations.

Trucks in Georgia are owned and retired when the maintenance costs start to exceed the depreciation cost, which they track. They usually buy trucks that are 3 to 4 years old and have 150-200k miles on them. The interviewee projects workflows and presents information to the COO, who then sends it to the CFO. The executives get a say in the quantity and demand for vehicles; specs are the sole discretion of the interviewee as managing director. Owned trucks are sold by word of mouth and usually go to farms or are sold to independent contractors.

They keep track of maintenance through daily driver inspections and through weekly and monthly evaluations of maintenance costs. When the interviewee sees a pattern of more major repairs, they start to look at retiring. For example, the diesel exhaust fluid (DEF) shortens the life of the engine, and if they start to see many invoices for replacing the DEF system, that's a sign to retire. The interviewee has seen longer wait times for parts and repairs since the start of the pandemic.

One issue they face is that there are long lines at the Port of Oakland, which means their drivers might have to idle all day long for the possibility of getting one container. Another trend the interview notes is that drivers nowadays don't know how to drive manual trucks, so the company benefits from having all automatic transmissions.

Clients ask about the fleet's greenness, but the trucks tend to already meet requirements if they're leased. The interviewee is not interested in electric vehicles – doesn't see the value add over diesel, as emissions today are already much cleaner than they used to be. They have considered natural gas but are concerned about the availability of service areas for gas.

Interview Summary for Fleet Number: 57

1. **Region:** California
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 100 Trucks
4. **Truck type(s):** Class 2b, 3, 4, 6, 8
5. **Use-case(s):** Vocational, Medium-duty
6. **Buy or Lease:** Purchase
7. **Purchase condition:** New and used
8. **AFVs:**

Keywords

Decision Making Structure: Sole (decisions are made by the owner, who does not take into consideration input from the interviewee, maintenance team, or drivers)

Adaptability: Reactive (they follow the lead of other large construction companies and are keeping an eye on potential regulations without taking any action before they are required)

Complexity: Simple

Inputs to fleet turnover decision-making: *Brand loyalty* to Chevy (for medium-duty trucks) and Mack (for heavy-duty trucks) is the main purchase consideration. Other brands are used only if there is no *availability* of preferred brands.

How are these inputs used: The owner prefers to have a standardized fleet to keep maintenance costs low, however, maintenance costs are not necessarily one of the reasons why they choose the brands that they did.

Summary

Fleet 57 is a construction company which operates a majority ¾ ton Class 2b pickup trucks, which carry materials. They also have 1- and 2-ton trucks (Class 3 and 4), which carry some of their heavier loads (lumber, rebar, etc.) and act as pour trucks. The Class 8 truck is a dump truck that hauls materials away from the construction sites. Approximately 10% of these vehicles are taken home by the employees at night and the rest return to the fleet yard.

The interviewee oversees truck retirement decisions for the fleet while truck purchase decisions are made by the Vice President and Executive General Manager of the company, who the interviewee works with. The in-house maintenance team gives feedback on the trucks they work on, but they are not really involved in the purchase process or decision. With regards to the overall purchase process, the interviewee describes the company as having a "mom and pop feel to it," referring to the informality of purchasing decisions.

Truck purchase decisions are based largely on meeting the specific needs of the company. Their Class 2b and 3 trucks are purchased new while the larger trucks are purchased new or used, depending on availability (they prefer new). The smaller vehicles typically acquire more miles annually than the larger trucks, so they wear out faster, and therefore they purchase new vehicles. While the class 2b and 3 trucks are typically purchased new, the interviewee notes that they purchased their first used Class 3 truck a few months ago due to the shortage of new trucks. This decision is based on “how badly we need it, what kind of position we’re in.” The Class 8 trucks are typically purchased used, with one truck being purchased new due to availability.

The owner of the company prefers Chevy trucks because, “it’s been a good, decent, solid running truck.” The interviewee notes that they also have some Fords in the fleet because Chevy trucks are not always available. For the Class 8 trucks, the fleet only purchases Mack trucks because, “Mack has been really great at what we need.” They chose to stick with Mack because their maintenance team is familiar with them and standardization helps keep costs down. If they were to switch to another manufacturer to save costs, they would want to see proof of strong cost savings. They often follow the lead of larger construction companies when trying out new technologies (e.g., safety features, fuel types, etc.).

Fleet 57 keeps their trucks for 15-20 years, which the interviewee attributes to the good work of their in-house maintenance team. When the fleet is done with the vehicles, they either scrap or resell them, which sometimes includes selling to employees. They will occasionally keep retired trucks around to use their parts in new trucks, however, the owner, “doesn’t like keeping too much junk lying around, it’s not a junkyard.”

The interviewee has been keeping track of the alternative fuels market because he is aware that, “by 3025, we’re supposed to be electric.” He doesn’t believe that an electric truck would be durable enough for the construction application. While he is keeping track, he is not optimistic about the technology, “I wouldn't call it openness, I’m just saying it's inevitable… I don't want to get slapped in the face by it [when they say] ‘okay, here we go, that's it, you got to change and make it work.’” He believes the lack of charging stations, limited range, limited carrying capacity, and cost would be barriers to electric truck adoption. The interviewee was similarly skeptical about natural gas trucks because they have different parts and a different operating system, leading him to conclude that, “it was probably never a way for us to go.” The interviewee has proposed the idea of alternative fuel vehicles to the owner, but he was uninterested in the topic.

Interview Summary for Fleet Number: 58

1. **Largest region over which fleet is operated:** National (Company is in several states, but vehicles operate locally or regionally around specific locations.)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 250
4. **Truck class(es):** Class 2b-6
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Purchase and Lease (and rent)
7. **Acquire new, used, or trucks in both conditions:** Both new and used
8. **Hybrids or AFVs currently present:** No [This is a correction made near the end of interview: he had checked "hybrids" on questionnaire.]

<u>*Keywords*</u>

Decision Making Structure: Hierarchical. Interviewee (Vice President) has the authority to create an annual plan of which trucks to acquire or retire including decisions to purchase, lease, or rent individual trucks for each branch. He solicits input from branch managers in this process. Actual expenditures require CFO approval.

Adaptability: Reactive. There is an elaborate process of tracking data, ranking metrics, and cost comparisons, but it focused on experience ("historicals") and present conditions. Fleetwide acquisition/retirement process is calendar-driven (annual), not data driven or forward-looking.

Complexity: Complex

Inputs to fleet turnover decision-making

1. Weak brand loyalty, subject to responsiveness of dealership and truck class.
2. Annual ranking of every truck's odometer, maintenance expenditure, age, usage.
3. Modified by extenuating circumstances; including, regional differences in state costs, e.g., taxes, and product demand; then,
4. "TCO" = annual cost to own and operate truck compared to revenue from the location to which the truck is assigned, then,
5. Branch reports, then,
6. Hand it all over to a fleet management company to acquire and retire the trucks.

How are these inputs used?

As implied by the list of inputs above, there is a complex, data-driven multi-actor process to produce annually a list of recommended fleet transactions. These decisions include whether to replace an existing truck and if so, whether to replace it with the same type (class) of truck

<u>*Summary*</u>

Interviewee is Vice President of Logistics and Operations for a wholesaler of HVAC parts. They might not sell, say, a Trane air conditioning unit, but they would sell the compressor needed to repair it. Their customers are HVAC contractors. They own a fleet of 250 vehicles ranging from Class 2b vans to Class 6 box trucks. Trucks operate out of 225 branches located in several states; Florida, California, Texas, and Tennessee are mentioned in the interview. The fleet operates vehicles from Class 2b vans to Class 6 trucks. The majority are "box" trucks—a category he says includes vans—and some stake trucks (a flat bed with "fenced" sides). Maximum truck size is determined by limiting truck weight so that no CDL is required.

He brought with him a personal preference for Ford vehicles which he implemented in buying trucks for the fleet—which is of a wide variety of truck classes, bodies, (vans, box trucks). However, this loyalty is weak. When Ford stopped being proactive and could not deliver trucks, he switched to Chevrolet. The larger trucks are Freightliner.

Much of which truck to buy is determined by operational concerns that vary by region:

> *"So, California it doesn't rain, and the air conditioners go on the roof—perfect conditions for stake beds; Florida it rains every day and the air conditioners, not on the roof, there's, not a single stake bed in Florida. There're benefits of a stake bed as you know, ...you can unload it from all sides a little bit easier ... But normally it's weather and type of delivery that drives the decision, and I would say, probably overall maybe 10% of our fleet is a stake bed right. The majority of it is a box truck and I'm considering a van a box truck in this discussion."*

Which truck a branch has also depends on whether it tends to mostly sell parts and supplies—vans and smaller box trucks—or larger units—larger trucks.

As outlined in the list of determinants, there is a multi-step process which starts with an inventory and ranking of all the trucks. Ranking was done from 1 to 250 (the number of trucks) in categories such as odometer, maintenance expenditure, age, usage. Now, the rankings are done in bins or ranges. Still each rank order assigns a low score to a truck that should be reviewed for removal (e.g., high miles, high maintenance cost, etc.) and high scores to a truck that may be fine to keep (e.g., low miles, low maintenance cost, etc.).

Scores are then added across categories, a new ranking produced, and then those trucks with low scores are reviewed for retirement. Each branch is then queried about their truck. For trucks marked for retirement, does the branch concur? Do they want the same type of truck? Based on the amount and type of business the branch is doing, the "central" plan may indicate a different truck may be appropriate. A growing branch may be a candidate for a larger truck. Sometimes, these replacements may not be a new truck but a switch of a truck from one branch which has demonstrated over the past year it is not fully utilizing a larger truck to a busier branch. All this is compiled into a plan for acquisitions and retirements which is then reviewed with the fleet management company that handles all truck acquisitions and retirements. Specifics of truck specifications, designs, and make-models are negotiated and a final spending plan produced. This plan must be approved by the company Chief Financial Officer.

The ranking system is relative; trucks are ranked against each other, not rated, (e.g., pass-fail) against any benchmarks. Fleet turnover decisions are predicated on branch operations—revenue, types of goods shipped, local market conditions.

Interview Summary for Fleet Number: 59

1. **Largest region over which fleet is operated:** Multi-state across nation
2. **Ownership Model:** Centrally-owned.
3. **Fleet size:** ~900 (825 active) ~400 Ford Transit vans, remainder medium and heavy-duty
4. **Truck class(es):** Transits 2b; rest range from 3 to 8 including large buses
5. **Use-case(s):** Passenger shuttles: Transits for airports, remainder campuses
6. **Buy or Lease:** Buy
7. **Acquire new, used, or trucks in both conditions**: New
8. **Hybrids or AFVs currently present:** Almost all Transits refitted to propane

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to fleet turnover decision-making
Fleet 59 has two purchase processes. Ford Transits, used as regional passenger shuttles to airports, are routinely purchased based on a single specification developed years ago by the interviewee. Medium and heavy-duty vehicles, used as shuttles on campuses, are specified by end-users. Fleet 59 bids on RFPs, and if successful, finds, purchases, deploys and operates the vehicle for the end-user with all costs recuperated through an hourly rate. The VP of fleet services spearheads actions regarding purchases and vehicle *turnover* but "manages by committee", relying heavily on several individuals throughout the organization to inform decisions. Fleet 59 has an *aggressive maintenance program* that allows them to extend the useful life of vehicles. They also keep detailed records of all costs to conduct a *cost of ownership* analysis which is presented as a single "cost-per-mile" metric. They use this metric along with repair frequency and mileage to determine vehicle life. Retired vehicles are sold through several resellers who are part of a *critical network* the interviewee depends on to operate the fleet. Fleet 59 is aware of and anticipates *CARB regulations*. They are interested in electric vehicles and are purchasing a few to analyze before deciding on additional purchases.

How are these inputs used?
Interviewee has been in the business for 38 years and states he has a lot of operational leeway. He introduced a rigid data-driven practice to determine the cost of ownership and turnover intervals. He also interacts with several individuals when making fleet purchase and retirement decisions. Some of these individuals are at his level or higher in the organization but he also relies on individuals in the field to monitor and report on vehicle performance. They have weekly "operation team" meetings where feedback is provided by various positions, including mechanics. The interviewee made several comments regarding how long their vehicles last because of their aggressive maintenance program, noting most of their Transit vans undergo two engine replacements. His knowledge of the industry along with 20 years in the Coast Guard helped shape his methodical approach to fleet management. The interviewee also stressed the importance of relationships and networks he has developed in the fleet industry. He is a big advocate of electric vehicles (personally owns two Tesla's) and plans to purchase four electric Transits to see how they work out. All the other Transits in the fleet have been converted to

propane (except those operated in California where it is “not allowed”). Conversion to propane provides a favorable cost-of-ownership because of federal subsidies and much lower fuel costs.

Summary

Approximately half of Fleet 59 is Ford Transit vans for airport shuttles and the other half are medium and heavy-duty trucks and buses (Internationals, BlueBirds, Ford 650s) that are used for campus shuttles. They own and operate all these vehicles. Fleet 59 must bid on campus shuttle contracts. These contract vehicles, which include several large passenger buses, are spec’d by the end-user and Fleet 59 fulfills the order on their behalf. Fleet 59 then delivers, deploys, and operates the vehicles. They recoup their full-service costs through a calculated hourly rate. The interviewee, along with a senior VP are primarily responsible for procuring the campus vehicles. On the airport side (Ford Transits), fleet 59 is the end-user and, therefore, vehicle purchases are more routine. All vehicles are purchased new.

Fleet 59 collects detailed data on their vehicles and conducts cost-of-ownership analyses to determine when to retire a vehicle. They rely on in-house data and third-party software to conduct these analyses which are summarized in a “cost-per-mile metric. For every vehicle, they look at “what it cost brand new, what it costs now, and what is the breaking point”. Vehicle retirement is based, in part, on mileage (700K is automatic retirement). However, “mileage is nothing but a number”, so the cost to run ($/mile) and “out-of-service” (frequency and duration of downtime) are also key metrics used for determining turnover. They have a very aggressive maintenance program and many of their Transit vehicles will have two engine replacements before being retired. Some maintenance is in-house and some is performed by hire.

The interviewee, VP of fleet services, is largely responsible for vehicle acquisition and retirement but he relies on several people inside and outside the organization. For example, he holds weekly meetings with the “operations team” (regional managers, supervisors, fleet managers, mechanics, etc.) to determine vehicle needs and status. His office manager, who is “very sharp” keeps a master list of data (consisting of 100 columns) for all 900 vehicles. Other VPs and the company president either participate or are kept apprised of important vehicle acquisitions. He also relies on a network of individuals and companies to sell used vehicles. The interviewee, despite being a VP, is very “hands on”. He has worked on vehicle repairs and obtained a commercial license so he could drive the buses. He “manages by committee,” so he welcomes feedback from several people throughout the organization.

Fleet 59 is aware of forthcoming regulations. They upfit the Transits with propane because of low propane prices and federal subsidies. They calculated the payback period to be about 3 months for the $6K investment per vehicle. The interviewee explained their internal policy to “do their very best to save the environment”, which is why they use propane (although cost savings seems to be, by far, the more significant motivator). Campuses are requesting electric buses but balking at the price. Therefore, Fleet 59 is countering with diesel-electric hybrids (although it is unclear if they have implemented any). They plan to buy four electric Transits but the range is only 126 miles so they will put them on limited routes over four seasons and then assess performance before investing in additional electric vehicles. The interviewee personally owns two Tesla cars and really likes the performance and cost savings.

Interview Summary for Fleet Number: 60

1. **Region:** National/Regional (California and Arizona)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 45 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: *Niche operational needs* create the need to purchase new vehicles and work with only one manufacturer. *Total mileage* and *maintenance costs* (compared to residual value) are used to gauge retirement decisions. *Vehicle weight* is a major factor for this fleet and is a hurdle for electrification.

How are they used: The interviewee makes all major fleet decisions. Decisions are made holistically, with consideration of market conditions and industry trends, rather than solely metrics based.

<u>*Summary*</u>
Fleet 60 hauls agricultural items like trees, fertilizers, and irrigation equipment. Most of the fleet consists of double curtain vans, pulled by two-axle tractors. The fleet operates mostly in the Central Valley of California but also works in Arizona. The interviewee is the vice president of the company and supervises operations and purchases, among other duties. They have custom software for tracking and managing operations. The interviewee is an advocate for e-logs for trucks.

The company buys new trucks because they run a non-standard tire and wheel combination that allows them to be lower to the ground and to manage weight in a specific way. Manufacturers worked with them to test out the alternate setup, and Volvo exclusively makes this particular spec. This means they can only buy new. They get a 5-year, 500k mile warranty. The interviewer is looking to shift away from the 53-footer heavy trucks and move towards “hotshots,” i.e., dual-axle medium-duty trucks or “dualies”.

They typically turn over trucks at 600-650k miles, but sometimes up to 800k miles. The decision to retire a truck comes down to how it looks, and its maintenance cost versus value. Trucks are usually sold directly to other truck operators. The company does minor repairs in-house and sends major repairs to Volvo.

They have an issue with getting good drivers but don't think there's a driver shortage. Their drivers are employees who are paid hourly and get benefits. They have trouble getting drivers who are willing to drive to Arizona and spend nights away from home.

The interviewee garners information from customers and competitors about how to set hauling rates. Fuel is one factor in setting rates. The interviewee places great importance on getting information from others in the industry who have learned through experience.

Regarding AFVs, the interviewee is concerned about the increased weight of electric trucks, particularly because they built a custom specification just to manage weight. Another concern is the lack of charging infrastructure on their lot and on the road. They tried building a makeshift fuel cell truck but couldn't figure it out.

Interview Summary for Fleet Number: 61

1. **Region:** Lower 48 U.S. states
2. **Ownership Model:**
3. **Fleet size:** 30 trucks
4. **Truck type(s):** Class 8 tractor trucks
5. **Use-case(s):**
6. **Buy or Lease:** Buy
7. **Purchase condition:** New
8. **AFVs:** N/A

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The operations manager (son) and the President (father) make collaborative decisions about truck retirement and acquisition. The fleet intentionally uses all Volvo Class 8 tractor trucks with the same specification. Each truck runs about 15,000 miles per month (180,000 miles per year). At about the 700,000-mile / 4-year mark, the fleet looks to sell the truck, but maintenance costs also factor into the decision.

How are they used: Company leadership leans hard on their judgment, but it seems that they're on a fairly set replacement schedule at 700,000 miles / 4 years.

<u>*Summary*</u>
Fleet 61 operates across all 48 lower U.S. states. The roughly 30-truck fleet consists exclusively of Class 8 Volvo tractor trucks based on the President's positive experience with Volvos over the years.

The fleet always buys new Volvo trucks with the same spec from the same dealership. Brand continuity is intentional and simplifies their operations. Drivers and technicians only need to be familiar with Volvos, and it also allows them to keep spare parts in stock. Fleet 61 does most of the minor and preventative maintenance in-house.

Truck leases do not work for their operation because leases have maximum mileage limits, and additional miles over that limit cost extra per mile.

Fleet 61 laments the myriad of regulations in California and the overall climate that makes running a business more challenging. They are almost to the point where operating in California is more trouble than it's worth.

By far, it seems that the emission control systems (including the diesel particulate filter and selective catalytic reduction systems) present the biggest maintenance costs and reason for unscheduled downtime.

Interview Summary for Fleet Number; 62

1. **Region:** National/Regional (Multi-state)
2. **Ownership Model:** Centrally-Owned
3. **Fleet size:** 16 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul), Heavy Duty (Short-haul, day truck)
6. **Buy or Lease:** Purchase Only
7. **Purchase condition:** Used Only
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical, sole
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Total mileage* and *frequent repairs* are the main drivers of fleet turnover, with *fuel economy* as a minor metric that they track. *Driver availability* limits how many trucks the company can reasonably have. *Emissions regulations* have also played a big role in the company's truck ownership model. The company prefers *fleet uniformity* and therefore maintains *brand loyalty* to International and Cummins.

How are they used: The interviewee works closely with the company's owners to make fleet acquisition and turnover decisions. They exclusively buy International trucks with Cummins engines, and they work with a local International dealer to acquire them.

Summary
Fleet 62 is a small freight carrier transitioning from regional (Western U.S.) to more local routes where their drivers typically come home every night.

The change is primarily due to a shift in the driver labor market, where it is harder to get more long-haul drivers. They are also facing competition from larger companies that can offer higher driver compensation. If drivers were available, the interviewee would like to increase the number of trucks. However, this depends on the owners of the company, who may not want to expand as they are older and looking to retire soon. Typically, each truck is assigned to one driver, although in special circumstances they may reassign (e.g., breakdowns).

Previously, the company bought used trucks from larger fleets at around 500k miles and used them until they reached 1.2 to 1.3 million miles. With the implementation of the 2010 CARB regulations, they had issues with the maintenance costs required to comply. To comply and to reduce those costs, they leased approximately 70% of their fleet from Ryder and eventually came off those leases to purchase used trucks again. All the trucks that replaced their Ryder trucks are International trucks with Cummins engines. International has good truck availability, and the owner likes the performance and reliability of Cummins engines. The company bought these trucks from an International dealer who got them from a JB Hunt fleet.

The company has aggressive servicing: they do oil and filter changes every 15k miles. They keep copies of all the maintenance done on each truck but don't do anything too formal because it's easy to know the full history of each truck in a small fleet. They also track fuel economy through the trucks' electronic logging devices (ELDs).

Trucks approach retirement at around 700k to 800k miles. Once they are ready to retire a truck, it gets sold to a dealer, an owner-operator, or to a fleet in Mexico. Outside of the 16 trucks in the fleet, there are a handful of owner-operators (1099) who contract with the company and bring their own vehicles.

The owners are spouses who lead the decision-making for acquiring and disposing of vehicles. The interviewee handles logistics and regulatory compliance. The interviewee gets information from the CARB website, email subscriptions, and webinars. CARB is also a source for truck technologies and performance, along with truck salespeople.
The interviewee is open to following the industry in a shift to electric vehicles but would not be an innovator.

Interview Summary for Fleet Number: 63

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 250 Trucks
4. **Truck type(s):** Class 2b, 3, 6, and 7
5. **Use-case(s):** Heavy Duty (Short haul, day truck), Heavy Duty (Vocational with Power Take Off), Medium-duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Reliability* and *durability* are major factors for the company's choice of vehicle manufacturers, along with *purchase and maintenance costs*. *Tracking software* regularly prompts retirement decisions, although it is unclear what factors are accounted for by the software. *Operations in remote locations* prevent the company from pursuing electric trucks.

How are they used: The interviewee makes fleet decisions with the purchasing approval of the company owner. They keep up with the CARB regulations but do not seem to actively seek out new specs or technology. The mentality is "if it isn't broke, don't fix it."

Summary
Fleet 63 is composed of three-axle tractors, 10-wheeler flatbed trucks, and medium-duty trucks from F150s to F750s. Approximately 100 trucks are medium-duty, and the rest are heavy-duty. The interviewee is the transportation manager for the company, which is an umbrella organization for multiple businesses within the construction sector. The company does 70% of its work locally and 30% in other states including Nevada, Arizona, Utah, Michigan, and Texas. One division owns all the fleet vehicles and leases them to the other divisions. The interviewee evaluates whether the company needs more trucks, while the company's owner purchases the vehicles. They both have many years of industry experience and trust each other's judgment. Most of the company's drivers don't drive as their primary job; they are driver-laborers.

The company purchases new vehicles from a dealer and used vehicles from rental companies or through online auctions. The heavy-duty trucks are a mix of Kenworths, Freightliners, and some Peterbilts, but the medium-duty trucks are almost all Ford. The interviewee finds that Fords seem to last the longest and retain resale value. For tractors, Kenworths have been great for durability, but they are now transitioning to Freightliner for the lower purchase price and cheaper maintenance.

Fleet 63 tracks costs using software that monitors engine hours, total mileage, maintenance, and repair costs. They have two full-service maintenance departments and do everything in-house.

The software lets them know when trucks are coming up to be replaced. Retirement is also driven by CARB emission regulations but working trucks that are out of compliance are often relocated to another state. Trucks used to be cannibalized for parts and then scrapped, but they realized they can make more money from selling the trucks. Some retired trucks are sent over to other countries like Indonesia or Cambodia.

They have avoided AFVs because they operate in remote areas and find it useful to have all their equipment, compressors, pumps, and vehicles running on diesel. The interviewee believes that a transition to zero-emission will be challenging for the company's operations. They also tend to leave larger equipment at job sites for around a month which precludes charging. The medium-duty trucks such as F150s and F250s go home with employees and could be more easily charged. They have investigated incentives but that isn't a driving factor for them. For now, the company is just trying to be CARB-compliant.

Interview Summary for Fleet Number: 64

1. **Region:** California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 2 Trucks (and two cargo vans)
4. **Truck type(s):** Class 6 (2); Cargo Vans (Class 1 or 2b?) (2)
5. **Use-case(s):** Medium Duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** Hybrid

Decision Making Keywords: Reactive, sole, simple

Inputs to decision-making: *Dealership connections* and *operational needs* drive vehicle purchase (and rental) decisions. *Total mileage, breakdowns, and interior wear* are considered for vehicle retirement. Benefits of AFVs to the fleet include *decreased fuel costs, decreased maintenance, and a green public image*, although the interviewee expressed hesitation over *vehicle range* and *electric grid concerns*.

How are they used: The interviewee is the sole decision maker on transportation decisions. With such a small fleet, purchase and retirement decisions are made on a case-by-case basis. Some metrics (mileage, fuel costs) are logged digitally, and others (maintenance costs) are loosely tracked.

Summary

Fleet 64 delivers plants to garden and home improvement centers across California. The fleet is composed of two Ford cargo vans (Ford Transit Connect is Class 1 while a Ford Transit is Class 2b; there isn't enough info in the summary to know which "Ford cargo van" this fleet operates) and two trucks (Isuzu and Hino). The interviewee is a co-owner of the company and has the final word on fleet decisions.

The company buys both new and used vehicles. The interviewee has a connection that owns a Ford dealership, so the company gets good deals. Their Isuzu truck was bought used from Penske. The interviewee has a good history of renting Isuzus and prefers the brand. For future truck purchases, the company also has a connection with Isuzu. The Hino truck is hybrid and is best suited for stop-and-go routes, while the Isuzu is diesel and gets sent out on longer routes. The company started having problems with the Hino hybrid and had to spend tens of thousands on repair while it was running longer routes. They found that realizing the benefits of the hybrid truck required running it on shorter routes. In addition, they rent a 26-foot box truck for a week every month to do their northern California route.

The interviewee installed GPS trackers that allow the company to track driver locations and mileage. With the current high fuel prices, the interviewee aims to be more efficient with their routing and avoid long, single-delivery routes. They can also optimize by sending out a van instead of a truck. The company tracks fuel costs through fuel cards.

Most maintenance is done at an external shop, while oil changes and minor inspections are done through a mobile unit. They loosely keep track of maintenance costs. They buy warranties for their trucks and vans but have had issues with dealers not honoring them and repairs taking weeks to complete. When vehicles are in for repair, they just shift around their vehicles and routes to make things work.

In the past, they have put as many as a million miles on a truck, but nowadays they start thinking about engine and transmission repairs around 500,000 miles. Retirement can be triggered by total mileage, breakdowns, or even interior wear (e.g., seats).

Company drivers start out as delivery drivers and then transition to becoming sales reps. They haven't had a hard time finding drivers, although they require drivers who can be dedicated enough to be on the road by 5:00 AM.

The interviewee reads regulations but many of them don't apply to their relatively small fleet. They have been offered electric vehicles but want at least 200 miles of range, preferably 300 miles. They would be willing to pay up to a 50% premium. Fuel cost is the primary benefit, with maintenance and public image being second and third, respectively. The interviewee is wary of the effect of EVs on the electric grid and would prefer a plug-in hybrid for personal use. They don't currently see electric vehicle usage within their industry.

Interview Summary for Fleet Number: 65

1. **Region:** National/Regional (Multi-state)
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 15 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Short-haul, day truck)
6. **Buy or Lease:** Purchase Only
7. **Purchase condition:** Used Only
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical, sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Total mileage* and *maintenance costs* are the biggest inputs, although the *truck shortage* has shifted their standards. *Ease of repair* influences their choice of a truck brand. CARB's *emissions regulations* promote the company to keep the fleet fairly new.

How are they used: Trucks are evaluated based on their overall profitability, and the ones that are unprofitable are turned over. The interviewee tracks total mileage, fuel mileage (mpg), and maintenance records, although they don't follow CARB regulations closely.

Summary
Fleet 65 is a family-run drayage company located in Wilmington, CA. They operate 15 trucks composed mostly of Volvo and Freightliner trucks ranging from the model year 2012 to 2016. Most (80-90%) of deliveries are within 100 miles, but some go as far as Phoenix, AZ or Las Vegas, NV. The interviewee discusses fleet issues with their family but serves as the final decision-maker for the fleet.

The company buys used trucks at auction at 300k-500k miles and runs them until around 800k miles. The interviewee notes that Volvos have fewer issues with their emissions systems, while the Freightliner Cascadia has a better cabin, engine power, and handling. Due to the limited supply this past year, the interviewee has had to buy higher-mileage trucks (800k miles) at a higher price ($48k). Even though this is the mileage at which they would normally sell trucks, the seats, wires, and hoses are less worn down than 10-year-old trucks with similar mileage. The interviewee doesn't think warranties are worthwhile.

They do in-house maintenance, including engine overhauls. Most of the fleet are Volvo trucks, which means that they can stockpile fewer parts. Volvo engines are smaller, and their oil changes are cheaper. They tried out a Cascadia with what was a new engine (DD15) at the time and found the brand to be reliable, but it took a couple of years to be familiar with in terms of repairs. The fleet has one Kenworth truck owned by the interviewee's brother. The interviewee says it is not profitable since it is heavy and has expensive parts. After learning about biodiesel from a salesperson, the company switched to biodiesel, which is cheaper, has fewer sulfur oxides (SO_X), and has allowed the trucks to run cleaner and with less maintenance.

30% of the fleet is not occupied by drivers, as the company cannot find enough. Some drivers are employees (W-2), and others are independent (1099). The interviewee's ideal ratio is 70/30 or 60/40 W2/1099 drivers. The interviewee notes that W2 employees must follow the dispatch, whereas independent contractors can switch to another load for another company on short notice. On the other hand, W2 employees are less productive after some time, whereas independent contractors get paid by the load and are therefore motivated to work as much as possible. The interviewee describes AB5 as affecting the company positively, as it set a standard for customers to pay more, and because it created a more competitive market for worker compensation.

For turnover, they review the profitability of trucks quarterly or annually based on their maintenance costs vs. how much they earn from carrying loads. The interviewee sells retired trucks in the used market (via Craigslist or similar sites) or at auction. The interviewee has experience operating a dealership buying trucks from a wholesaler and selling them for retail. They use software to track all units, including total mileage, repairs, and costs. They use a dashcam system that monitors miles traveled, and they combine it with fueling data to get fuel mileage. To keep trucks compliant with CARB regulations, they keep units between five and seven years old.

Although the Port of LA is starting to charge ICE trucks for their clean trucks fund, the interviewee is wary of natural gas. According to the interviewee, natural gas trucks experience more wear and have less power than diesel. They are more optimistic about electric trucks, as they have high torque and the range is not a concern given the company's operations. The interviewee hopes to get a few Tesla trucks by 2024 or 2025.

Interview Summary for Fleet Number: 66

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 68 Trucks
4. **Truck type(s):** Class 6 and Class 8
5. **Use-case(s):** Medium-duty (Delivery), Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical, sole
Adaptability: Proactive
Complexity: N/A

Inputs to decision-making: *High-quality specs* and *vehicle lifespan* are the biggest factors that determine vehicle purchases, although a lack of *vehicle availability* has forced them to rent and buy used trucks. The company has not had to retire vehicles yet, but they are monitoring *maintenance costs* and *driver feedback* to evaluate trucks. Electric trucks are suitable for the company's *operational needs* and are therefore an attractive option.

How are they used: The focus on high-quality, long-life trucks means that the interviewee invests in relationships with dealerships, salespeople, and manufacturers. The interviewee makes most decisions, with some input from regional fleet managers and drivers and with approval from the CEO.

<u>*Summary*</u>
Fleet 66 is a furniture company with 56 26-foot box trucks and 12 Class 8 tractors. The interviewee joined the company five months ago as the director of transportation and is responsible for vehicle purchasing. The interviewee sources vehicles and gets approval from the CEO. The company has only provided direct transport for two years, so they have not retired any trucks yet.

The company used to buy only used trucks but is now beginning to buy new trucks with upgraded specifications to maximize their lifespan. The long-term savings are based on experience rather than a specific calculation. Based on the interviewee's experience at a previous company, they want to send the spec sheet to manufacturers and have them bid to fulfill the spec. The company previously ordered 25 trucks from International, but they have been slow to arrive. To fill these gaps, the company has purchased some used trucks and currently rents 18 box trucks from Penske. Although they haven't retired any trucks, the interviewee foresees that they will retire trucks at seven to eight years. They are actively growing since they only have the capacity to make about half of their deliveries in-house and are outsourcing the rest.

Most deliveries are within 150 miles of their 17 distribution centers, rather than longer over-the-road (OTR) routes. Because the operations are spread out across the country, there aren't enough trucks in any one location to warrant having in-house maintenance. Therefore, they work with a maintenance company. The company manually collects data and will soon purchase software to collect and analyze data on purchase and maintenance costs to make better decisions on truck specs.

The interviewee values post-purchase support and dealerships that have deep knowledge of a company's trucking needs and the performance of all types of equipment. They also build relationships with the part manufacturers to ensure that they get the right level of preventative maintenance. The interviewee gets information from trusted salespeople and an industry network called the National Private Truck Council.

To keep drivers happy, the company has made adjustments including higher quality seats, better pay, and more predictable routes. For box truck drivers (who aren't certified truck drivers), the company started providing more in-depth training to increase driver confidence and reduce turnover.

The interviewee believes that cleaner trucks go with lower costs, along with fuel efficiency and better quality tires that last longer. At the interviewee's previous company, they tried to experiment with a mixed diesel and compressed natural gas vehicle but were disappointed with its fuel mileage and low power. The interviewee is more excited about electric trucks, as they would suit the range of their delivery operations. At their previous company, they implemented two electric yard trucks and they have been performing well. The biggest barrier the interviewee sees to electric vehicles is the cost of the vehicles and infrastructure.

Interview Summary for Fleet Number: 67

1. **Region:** Southern California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 38 Trucks
4. **Truck type(s):** Class 3, 4, 5, 6, and 8
5. **Use-case(s):** Heavy Duty (Short haul, day truck), Heavy Duty (Vocational w/ PTO), Medium Duty (Delivery), and Medium Duty (Vocation w/ PTO)
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** Hybrid

Decision Making Keywords: Proactive, hierarchical, complex

Inputs to decision-making: Acquisition is driven by *operational needs* for custom specs, and choices are made based on *financing*, *dealer relationships*, and *fleet uniformity*. Retirement is primarily driven by *total mileage/age/engine hours*, although *maintenance costs*, *company budget*, *market conditions*, and *CARB regulations* are accounted for.

How are they used: The interviewee makes fleet decisions with the CEO and the controller, with input from superintendents and shop staff. The decision-making process is complex, requiring multiple meetings and consultations from company staff and vendors.

Summary

Fleet 67 belongs to a construction company operating in Southern California. The diverse fleet consists of medium-duty Chevrolet trucks (Malibu, Equinox, Colorado, 1500, 2500), Peterbilt and International dump trucks and tanker trucks, and a tractor-trailer. Other equipment includes asphalt rollers and skid steers. The interviewee is the facility manager and makes final decisions alongside the CEO and controller.

The interviewee, with input from the CEO, controller, and shop staff, has focused on making equipment last because much of their equipment is custom-built. They created retirement targets for each type of equipment based on mileage, age, or engine hours. When a piece of equipment reaches its target, the team makes retirement decisions based on maintenance costs, budget, and market/supply chain conditions. This system was implemented five years ago because the company lacked record-keeping and decision-making, and the fleet was getting a lot of inspections, failures, and tickets. The interviewee saw the need and started this work by creating a fleet management manual.

The interviewee consults with superintendents and end users to determine what specs are needed for each vehicle. They stick to Chevrolet for all medium and light duty, Isuzu and Hino for other medium duty, and Peterbilt and International for heavy duty. Certain custom specs are done through external vendors, and some are fabricated and installed in-house. When purchasing new vehicles, the interviewee customizes as much as possible to avoid having to customize after the vehicle is already built. If they receive multiple bids providing the same product, they prioritize financing and dealer relationships. Previously, the fleet had multiple vehicles that were leased to own through Enterprise, but they ran into billing issues and stopped leasing with them. They currently lease their only tractor-trailer through National to reduce ownership and maintenance costs.

Since the pandemic, the interviewee has had to operate vehicles for longer than ideal. Moreover, used vehicles are much more expensive but are sometimes the only ones available. The company has a full-service shop and does a lot of in-house maintenance.

Retired vehicles are sold through wholesale buyers or auction houses such as Richie Brothers. For non-compliant dump truck chassis, they register them as non-operational with the DMV and use them exclusively on the lot.

CARB regulations have forced early retirements within the fleet and have lowered resale value because the market was saturated with many vehicles at once. The interviewee notes that there are uncertainties regarding fleet electrification. Superintendents drive their vehicles home; is the company going to pay for charging stations at their houses? The building owner also plans on redeveloping their land within 10 years, which makes installing charging infrastructure unviable in the short term. The interviewee wants to wait until prices come down and when there are fewer policy and infrastructure uncertainties.

Interview Summary for Fleet Number: 68

1. **Region:** National (Multi-state)
2. **Ownership Model:** Centrally Owned
3. **Fleet size:** 5 Trucks
4. **Truck type(s):** Class 2b, Class 5, and Class 6
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Both Purchase and Lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

Keywords
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: N/A

Inputs to decision-making: *Fuel efficiency*, *vehicle reliability*, and *vehicle availability* factor into purchase decisions, while *maintenance costs* and *regulations compliance* factor into retirement decisions. The same factors, particularly high fuel efficiency and low maintenance costs, make AFVs attractive option for the fleet.

How are they used: As a small business, they have built the fleet opportunistically and continue to make decisions on an ad-hoc basis. The owner is the sole decision-maker and is optimistic about electric trucks, although they do not actively keep up with CARB regulations.

Summary
Fleet 68 is a residential and commercial mover operating in California, Arizona, and Oregon. Their fleet consists of 16-, 17-, and 24-foot box trucks and an F350 with a 25-foot trailer. The interviewee is the company's owner and sole decision-maker for fleets.

Most of the fleet is from Monarch, a company that sells and services trucks, and operates a truck center. Opportunity and company need dictate whether they buy new or used. For their two 24-foot trucks, the company needed new and reliable trucks. The 2005 17-footer came from someone who was retiring, so that was an opportunity. The newest one is the first lease that they did. That was the only one available and the lease was the only one available due to the supply chain issues.

For a new truck nowadays, they may look to lease from a company like Enterprise. The company ordered a truck from Monarch last year, but it still hasn't come in. For a future 24-footer, they would buy a new one through Monarch or through an International dealer.

The interviewee may keep the 17-foot truck depending on whether it complies with CARB regulations. Typically, the interviewee just goes to the DMV where they find out whether they can register it or not, as it is not clear whether a vehicle complies. They did not expect the 17-footer to be registered, hence the additional truck purchases and leases from Monarch.

The company has had issues with hiring people since COVID hit. Now, they spend as much on hiring as they do on marketing. Their box truck drivers don't need CDLs. Still, there is not a lot of labor available right now.

For the leased truck, the leasing company does all the maintenance. It's more expensive but the cost of trucks has gone up dramatically anyway, so the owner is fine with the increase. They used to rent but because it is more expensive, they currently only rent trucks when jobs call for multiple trucks. For owned vehicles, the company uses maintenance centers. Their used trucks are always past their warranties, and the company does not buy extended warranties. The company uses a bookkeeping company that tracks costs for them. However, the interviewee also tracks fuel consumption and maintenance.

The interviewee has at least one retired vehicle sitting in their lot. They have yet to sell a truck, although they have a buyer in Washington interested in buying their oldest trucks. CARB regulations help with knowing when vehicles should be retired.

The fuel savings and decreased maintenance needs on AFVs make them very attractive to the interviewee. However, they have run into availability issues with buying hybrid trucks in the past. They would like to install solar panels and charging stations but struggle to get a hold of solar companies. Another issue is that heavier ZETs may require their drivers to have CDLs. As a small company owner, the interviewee is concerned that the process will be too complex to navigate and that incentives will only be accessible to large companies.

Interview Summary for Fleet Number: 69

1. **Region:** Northern Central California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 25 Trucks
4. **Truck type(s):** Class 3, 5, and 6
5. **Use-case(s):** Heavy Duty (Short haul, day truck), Medium Duty (Vocational with Power Take Off)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole; egalitarian
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The company values *fleet consistency* and *manufacturer relationships*, which leads to *brand loyalty* for purchase decisions. Retirement is driven by *total mileage* and *maintenance costs*, although they are occasionally accelerated by *regulations*. *Vehicle range* and *concerns about the electric grid* are barriers to adopting electric trucks.

How are they used: The company tracks factors informally and makes decisions on a case-by-case basis. The interviewee works with the senior manager and mechanic for fleet decisions, although they are the final decision maker as the owner. Although the interviewee does not see electrics as a current viable option, they are proactive in regularly evaluating this.

Summary
Fleet 69 belongs to a water treatment company operating in Northern Central California. The fleet is composed of Ford F350s, F550s, and F650s. Technicians doing installation and repair of equipment drive the 350s, while delivery staff drives the larger trucks. They also have sales reps who drive hybrid Ford Fusions. The interviewee is the owner/CEO and serves as the fleet manager. The interviewee holds regular fleet management meetings with the senior manager and the mechanic.

The company sticks with Ford vehicles because they are used to their standards regarding specs, body/cab/chassis sizes, etc. The parent company has a relationship with Ford, which affords the franchise a discount. Trucks are outfitted with a custom body for carrying tanks. The technician trucks need the carrying weight of at least the F350. They occasionally reuse bodies, so they just need new chassis for those vehicles. The company experimented with ordering a transit van to better enclose their products but never ended up getting it. Delivery vehicles change routes daily, rotating on a 20-work-day schedule.

Retirement is based on mileage and service history. The company starts assessing vehicles seriously at 150,000 miles, although retirement decisions are influenced by maintenance costs and service issues. Each truck is evaluated individually. Certain high-mileage vehicles may be shifted to use as standby/spare trucks. The company has a tenant that buys its retired cabs and chassis, so the company does not sell in the open market.

The company has an in-house mechanic but outsources major or specialized work. They track maintenance costs without software. However, each vehicle has telematics that tracks driver behavior and has anecdotally decreased service work and fuel costs. This was a fortunate side effect of wanting to increase safety and decrease accidents and losses.

The interviewee follows mandates as they come but begrudges being forced to retire trucks early when they still have life in them. Mandates tend to speed up retirement by a year or two. Recently, the interviewee has experienced a shortage of drivers and other staff.

The company is keeping an eye on electric vehicles but has determined that current ranges of 120 miles are not long enough for their deliveries. Understanding that vehicle range will increase with future releases, the company is preparing and researching charging for their fleet. The interviewee plans on tracking each model year release to reevaluate. Lower operating costs would be a notable benefit, while the public image of being green would only be a minor benefit for the interviewee. The interviewee is also concerned about the impact of increased electricity demand on the grid.

Interview Summary for Fleet Number: 70

1. **Largest region over which fleet is operated:** Local or regional: Southern California
2. **Ownership Model:** Driver-owner
3. **Fleet size:** Four
4. **Truck class(es):** Class 4 — 14,001 to 16,000 pounds
5. **Use-case(s):** Medium Duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Acquire new, used, or trucks in both conditions:** Both new and used
8. **Hybrids or AFVs currently present:** No

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Simple

Inputs to fleet turnover decision-making

Repair costs (Separate from maintenance costs; on this basis he sold the first truck he bought, a Ford step van and bought two Mitsubishis new from a dealership).

Power as it affects suitability for routes. (On this basis he bought one Isuzu, then another because they are more powerful than the Mitsubishi's and thus better suited to the longer drive to the naval base).

Truck availability and emissions regulations (Mitsubishi has stopped making diesel trucks based on their inability to build a reliable emissions system, so he bought one Isuzu used from Ryder, then another).

How are these inputs used?

The owner is the sole decision maker about truck purchase and retirement. There is no discussion in the interview of whether or how the business owner integrates costs over categories or time. He conducts research to solve specific problems, implements a solution until it doesn't work, then researchers a new solution. The identification of problems is both "what is going wrong today" e.g., repair costs of Ford step van, and forward looking. He has spent considerable time exploring electric vehicles, planning for next year when his older trucks (Mitsubishis) will no longer be allowed to be registered in California.

Summary
The small business owner operates a novel business model: he owns a bread bakery franchise and a separate cookie franchise, as well as doing contract work for a tortilla manufacturer. He presently owns four medium-duty, diesel trucks and hires independent contract drivers. Two of the trucks operate on routes delivering bread to local supermarkets, one truck delivers cookies to a naval base, and one truck delivers tortillas. The bread deliveries are local; the cookie and tortilla deliveries are regional, i.e., the routes are longer and involve more freeway driving. He describes himself as providing the trucks and managing routes; it is up to the independent contract driver of each truck on each route to make a success of that route. He says he pays his

drivers well, including bonuses and percentages of earnings on each route; he does not pay them a day rate. Because of this, he has had no trouble recruiting and retaining drivers. Drivers may provide some input into which truck they drive.
The business owner explored grants to buy electric trucks but has not been successful. He believes it is because his trucks (Class 4) are too small and that only heavier trucks qualify. He has had discussions with his electric utility. The utility seems interested in installing electric charging infrastructure on his property. However, he seems to be stymied by the high price of trucks and inability to identify a funding source to help defray the costs and no electric trucks to buy. He says he's been told that the electric trucks aren’t built until they have been ordered.

He'd like the retirement of his Mitsubishis to be part of acquiring electric replacements, i.e., the Mitsubishis would be taken off the road permanently. However, if he can’t get grants to help pay for the electric trucks, he’ll sell the Mitsubishis out-of-state.

Interview Summary for Fleet Number: 71

1. **Largest region over which fleet is operated:** Local or regional within California- Central Valley and Los Angeles
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 70, though per the interview only **ten** are classes 2b through 5.
4. **Truck class(es):** Class 2b-5
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Both Purchase and Lease
7. **Acquire new, used, or trucks in both conditions:** Both new and used
8. **Hybrids or AFVs currently present:** No

<u>*Keywords*</u>
Decision Making Structure: Siloed
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making
When to turnover vehicles: *total miles*. The threshold number of miles differs by vehicle type and manufacturer, e.g., 150k miles for Ford Transit vans, 400k miles for Class 5, diesel, Isuzu box trucks, and unknown for Mercedes-Benz (Sprinter?) vans because they only recently acquired two.

Adding vehicles and vehicle types: *experience* and *reaction to changing needs*. Also, *NOT fuel economy*.

Whether to purchase or lease: *financing terms*, especially interest rates.

How are these inputs used?
Either the interview doesn't reveal the decision making or it does and the decision making really is as simple as it sounds: As a truck approaches its heuristic range limit, start the process to replace it.

<u>*Summary*</u>
Fleet 71 is headquartered in the south San Joaquin Valley. It's service region extends into the Los Angeles basin and north up the valley. They started as an in-home appliance repair business. Over time they have transitioned to also provide service on larger projects and to make appliance deliveries for big box stores. Fleet 71 now runs 70 trucks, ten of which are in classes 2b to 5 and thus of specific interest. Across all classes (including light-duty), Fleet 71 includes vans and trucks from Ford, Chevrolet, Mercedes-Benz, and Isuzu.

Fleet 71 is on a long-term growth trajectory in terms of service area as well as types of services, They started 16 years ago doing home appliance repair that could be done with light-duty vans and now also do bigger appliance repair jobs and deliveries for big box stores that require larger trucks, up to Class 5. Truck type and class additions to the fleet were based on history (experience) and reaction to needs rather than proactive planning. For example, interviewee mentions running “undersize and underweight” as they started to transition to jobs requiring vehicles with greater payload.

Light-duty replacements seem routine and a lot is left up to the Ford dealer, “who knows what we want.” Larger truck purchases may be more considered, but a lot of it is in reaction to outside events rather than internal plans or policies. That they now run two Mercedes-Benz (Sprinter?) vans seems to be more a matter of availability during a time of limited truck availability. They bought extended warranties for these two vans because they had no historical data to judge their durability and reliability.

Fuel economy was mentioned as something that was specifically not considered. In another example of learning from experience rather than anticipating possible future conditions, the interviewee says he will consider fuel economy going forward, claiming his fuel bill has increased by $30k/month over the past year. Yet he subordinates fuel economy to both reputation for (or better yet, history within his fleet of) durability and power. Durability, i.e., the total miles heuristic, come first, then a tradeoff between the ability to haul loads over the long, steep grade between the south San Joaquin Valley and the Los Angeles basin. He says he has four trucks making that trip every day.

Asked about tracking costs, he says he does—at the vehicle level; but when to sell the truck comes back to the total miles heuristic. Asked if he aggregates costs, he says he has a sharp analyst; but when to sell the truck comes back to its total miles heuristic. Maybe it isn’t any more complicated than that—except buy an extended warranty if you end up with a vehicle for which you have no operating history.

Interview Summary for Fleet Number: 72

1. **Region:** California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 3 Trucks, 3 Vans
4. **Truck type(s):** Class 2b, Class 5, and Class 6
5. **Use-case(s):** Medium Duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None, but they have diesel hybrids

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: Fleet purchase decisions are driven by the *availability* of suitable vehicles. Retirement is driven by *total miles* and *high maintenance costs*, although retirement is currently being delayed by *supply chain issues. Vehicle range* concerns prevent the fleet from adopting AFVs, although *vehicle and charging infrastructure incentives* would help.

How are they used: The interviewee takes input from drivers, the wholesale manager, and the owner to find suitable vehicles. Purchases are sent to the owner for approval. Many decisions are based on “ballpark” estimates.

Summary
Fleet 72 belongs to a delivery company specializing in seafood. Their products are kept refrigerated but not frozen. The interviewee is the facilities manager and oversees infrastructure and the fleet. The interviewee consults with the owner and the wholesale manager to ascertain their needs and to source vehicles accordingly.

The fleet is composed of three refrigerated vans, a pickup truck, and two Hino reefer box trucks. The larger of the two Hino trucks does regional routes and does about 250 miles per day. Meanwhile, the small vehicles stay local and get around 150 miles per day. The fleet is designed to have redundancies so that if units are out of service, others can serve as backups.

The company typically purchases vehicles from used vehicle dealerships. They do not lease as the company would rather own vehicles outright and drive them until retirement. When they find a vehicle with relatively few miles on it for a good price, the interviewee sends the purchase to the owner for approval. The interviewee also brings a mechanic to inspect prospective vehicles. They do not purchase extended warranties for any vehicles. Beyond ensuring that they get reefer units, they don’t pursue other specs such as tailgates. They have ordered a new Hino truck, but it has not yet been delivered. This has led to the company “nursing” old vehicles for longer than normal. They use an online database to aid in determining whether vehicles would be suitable for CARB compliance.

Factors that feed into retirement include high maintenance costs, total miles, and a qualitative measure of how much time and effort a vehicle requires to keep it running. The interviewee garners information from the drivers and telematics. Driver input on vehicle health is considered, but preferences for extra comfort or amenities are not considered. Failure to comply with California emissions regulations can also be a trigger for retirement. Retired units can serve a “second life” as a stationary cooler for excess storage.

The interviewee does minor maintenance such as oil changes and tire replacements in-house. For more intensive maintenance, they have a provider on contract. The fleet’s telematics system provides a maintenance record and tracks fuel costs. The vehicles are fueled exclusively at commercial fuel stops.

The interviewee follows CARB regulations and movement around electric vehicles through informational webinars. The company doesn’t have any policies regarding clean vehicles, so the interviewee has discretion.

Switching to electric vehicles would require a change in operations as the company would have to build charging stations on-site. The main barrier to electrifying this fleet is the range of current electric vehicles. The interviewee would like to see projections for the expected range increase of vehicles so that they can plan their vehicle purchases and the accompanying charging infrastructure required. The interviewee is not interested in natural gas as they don’t believe it’s the right long-term solution. The interviewee gets information on AFVs from other fleets, government agencies, manufacturers, and dealers. Incentives are the most important factor for promoting AFVs, particularly incentives for building out infrastructure early.

Interview Summary for Fleet Number: 73

1. **Largest region over which fleet is operated**: Local or regional within California: San Diego to Palm Springs
2. **Ownership Model:** Centrally owned
3. **Fleet size:** Three trucks: two owned, one rental
4. **Truck class(es):** Class 6 — 19,501 to 26,000 pounds
5. **Use-case(s):** Medium-duty (Delivery)
6. **Buy or Lease:** Both Purchase and Rent
7. **Acquire new, used, or trucks in both conditions:** Used only
8. **Hybrids or AFVs currently present:** No

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making
High *truck purchase price*—linked to the *lack of truck availability*—prompts 73 to acquire used trucks. He developed an affinity for a specific truck *brand* (Freightliner), pushed at least in part by a cousin who worked for this manufacturer and would help 73 maintain his (at the time) one truck. He believes the brand has a reputation for high quality as evidenced by his observation, "…most of the box trucks you see on the road are Freightliner." As a newer business, he has retired only one truck—an '07 International that he did not know could no longer be operated in California until he tried to register it. Soon after that truck broke down; he sold it for parts.

How are these inputs used?
Interviewee runs most of the business of Fleet 73, his finance manager (and fiancée) is the other partner in the LLC. He puts together a "packet" to present to her when he wants to but a truck. She decides whether it makes financial sense. He says she has final say over these decisions. As discussed below, he claims to do research and to "crunch the numbers" in putting together these truck purchases, however, his grasp of specific numbers seems a little loose. For example, while able to cite the cost of an individual routine truck service, it is less clear whether he knows what his overall maintenance costs are. He talks a lot about different costs, but never articulates what number crunching means.

Summary
Though he alludes to a time he may have been an owner-operator, Interviewee 73 no longer drives. He and his fiancée formed an LLC; "I take care of…the logistics side of the company; my fiancé takes care of the financial." The fleet presently operates three trucks; it owns two and rents the third. The two owned vehicles are a 2015 and 2017 Freightliner Class 6 box truck; the rented truck (from Enterprise) is a Class 6 International box truck, model year 2020. He bought the '15 from a Richie Brothers auction in Florida and drove it back to California. He bought the '17 off an Enterprise used truck lot. Fleet 73 delivers consumer products such as appliances for a

big box store. One truck does "warehouse" delivery; two do home deliveries. Home deliveries are typically in the San Diego region but may be as far as Palm Springs.

He describes putting together "packets" of information for his fiancée/finance manager to review and says she has the final say. He talks about many different costs—purchase costs, maintenance contracts, insurance, rental costs, while specifically dismissing fuel economy as relevant (since he says there is no real difference between trucks. He says he "crunches the numbers." However, he says straight out he hasn't looked at his fuel bills lately and that he is "aware" of his maintenance costs—he has a sense of whether they are high or low, but he can't say for sure what they are. So, "crunching the numbers" may involve some pulling together records or estimates when he wants to consider whether to buy a truck, but his costs are not something he appears to track carefully on anything like a continuous basis.

In some respects, his decision making is reactive and simple. He previously had a 2007 box truck; he didn't know he would be unable to continue to operate it in California until he tried to renew its registration. In other aspects, his decision making is more proactive, though probably still simple. His truck rental is expensive; he'd like to replace it with another purchased truck. However, buying trucks now is also very expensive. Despite wanting to buy a truck to replace his rental, he imagines he might rent yet another one if he tests whether he wants to move into freight (business to business) rather than home delivery services. Again, the rental truck would allow him to test this move without having to take one of his existing trucks out of its present service and without having to buy another truck. All of this is part of his thinking about hedging against what he sees as a looming recession—if it comes, he thinks consumers will stop buying stuff and his home delivery business will decline.

In support of his point about how expensive trucks are now, a point to which he returns multiple times in the interview, he relates two stories. One, the used 2017 Freightliner he bought in 2020 for $36k is now selling for $85k. Two, the dealership from whom the LLC bought a light-duty pickup truck over a year ago just called him offering to buy it back for what he paid for it.) For now, he is busy enough to need a third truck, but if business should drop off, he can simply return the rental—he wouldn't have to go on making payments on it. [Ken: Here, he doesn't connect the high cost to him of buying trucks to being able to sell trucks for high prices despite the fact he makes this exact observation elsewhere: "…about three years ago…I went to a Ryder, a Ryder place where they sold their old trucks. And they were selling, you buy one for full price and you get the second for half off. (He laughs.) Well, I sure wish I had that opportunity today. I would have bought it. In hindsight, I would have bought like four of them and sold them, waited a couple years, and sold them."]

Interview Summary for Fleet Number: 74

1. **Region:** Regional (mostly California, some other western states)
2. **Ownership Model:** Mixed
3. **Fleet size:** 20 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Drayage)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Used only
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical, sole
Adaptability: Proactive
Complexity: N/A

Inputs to decision-making: *Total mileage* and *vehicle age* are used loosely to make purchase and retirement decisions. *Emissions/fleet regulations* drive the fleet to stay new. The company and its drivers value *vehicle quality*, leading to *brand loyalty* to a few brands. Concerns about *EV range* and *charger availability* prevent the fleet from adopting AFVs.

How are they used: The interviewee is the sole decision-maker, with some input from another owner. They plan ahead and anticipate upcoming regulations, albeit reluctantly.

Summary
Fleet 74 is a drayage company at the Port of Oakland with 20 heavy-duty, tri-axle tractors. About half are company-owned trucks and the other half are owner-operators. Drayage operations are mostly within California with some operations in Nevada and on rare occasions, as far as Montana. The interviewee is one of the company owners and is the final decision-maker for truck purchases. The interviewee's husband, another owner, has input on truck conditions. For the owner-operators, the company has no input on what truck they bring in.

In recent years, the company has been preparing for CARB requirements under ACF that non-ZEV trucks would have to be retired after 18 years of service or 800,000 miles, whichever comes first. They want to have compliant trucks ready to go so they have been building up their fleet with trucks of model year 2017-2019. Prior to this shift, all their trucks were owned by owner-operators. Currently, however, the company is not able to buy any more trucks because of the high price of trucks and fuel.

They usually buy trucks from a used dealer with no more than 600,000 miles to avoid engine issues. Mileage and price are the purchase factors. The fleet's top choice is Peterbilt, then Kenworth and Freightliner. They see Peterbilt as "the Mercedes of trucks," with good build quality and reputation. Company drivers also appreciate the premium aspect of Peterbilt trucks.

The company prefers doing repairs and parts replacements rather than replacing the whole truck until it gets too old to repair. They do minor maintenance in-house and go to another maintenance company for large problems. They don't have very formal records but roughly keep track of the trucks' maintenance schedules. Similarly, they "eyeball" purchase decisions by weighing several factors. The company yard does not have space to keep spare trucks for parts, so they sell them off to the secondary market.

The interviewee believes that the driver shortage is manufactured by laws in California and that the supply chain crisis is manufactured by politicians. Drivers must spend 3-4 hours waiting at ports, leading to inefficiency, while the trucks are getting more expensive. Missing five minutes could cost a driver hours, so ensuring that trucks remain in service is crucial. They almost don't want to keep operating in California due to all the regulations. The interviewee hears about regulations indirectly from news around the industry. A few drivers have expressed interest in becoming employees in the next year.

The interviewee believes that biodiesel would be better than electric vehicles, as they are concerned about EV range and charging requirements. As a tenant, they can't install their own charging stations even if they had electric trucks. They are also concerned about the lack of mechanics trained to work with EVs.

Interview Summary for Fleet Number: 75

1. **Region:** Regional (mostly California, some other western states)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 10 Trucks
4. **Truck type(s):** Class 5 and Class 6
5. **Use-case(s):** Medium Duty (Long-haul, line haul), Medium Duty (Delivery)
6. **Buy or Lease:** Lease only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Specialty company operations* require trucks of a certain spec and quality, which prompts the need to lease. Good *customer service* and *maintenance* through the leasing service allow the company to stick to full six-year leases. The *environmentally-friendly image* would make AFVs attractive.

How are they used: The interviewee is the sole decision maker for transportation. They focus on getting the exact vehicle they need and leasing so they don't have to deal with retiring old vehicles. The interviewee is compliant with regulations and open to alternative fuels though not actively pursuing them.

Summary
Fleet 75 is a Portland-based carrier that deals with high-end furniture, antiques, and art. They have a few service lines that span the west coast from Vancouver, BC to San Diego, CA. Certain items must be shipped non-stop, so the fleet has two sleeper (medium duty) trucks that can accommodate a crew driving 24 hours a day. If their operations expand nationally, they would be open to buying heavy-duty trucks for long-haul routes. As the company's transportation department manager, Portland branch manager, and IT manager, the interviewee is the decision maker for trucks and transportation.

They lease trucks exclusively from Ryder because they have gotten better customer service than from Penske. The trucks have specific needs to work with museums: air ride suspension and reefer units, which aren't available on most smaller cab trucks. The company worked with a box manufacturer called Morgan to create custom boxes. For the past seven or eight years, their trucks have been exclusively Freightliner M2s. The entire fleet complies with California's clean idle regulations, even those that operate in Washington or Oregon. Due to the specificity required, their leases with Ryder cannot guarantee that there will be a replacement vehicle in case there is an issue. However, both Ryder and Penske have 24-hour maintenance centers, which minimizes the need for replacement vehicles.

The fleet's trucks are leased for six-year terms, staggered by three years. The company used to buy out leases at the end of their lease terms, but the interviewee pointed out that it is not worth buying the depreciated vehicle at that point. If a new vehicle isn't available at that point, they can continue leasing month to month for a premium. The company has never had to end a lease early.

Although they have a few sleeper cabs, drivers rarely sleep in trucks as the company would rather have them well-rested in hotels. The typical company driver is a college educated, perhaps a working artist, and is usually driving for a day job while working on art. While COVID shifted the company's delivery drop-off process, the interviewee has not noticed a decrease in the available labor pool. One hiring challenge is that drivers can be uncomfortable driving box trucks in urban environments.

The interviewee expressed interest in exploring AFVs. They would need to ensure that they could get power to the reefer boxes. Clients would appreciate the company having a green fleet. If trucks were available and suited the company's needs, the interviewee would try out an electric truck even at a premium. The interviewee would prefer if Ryder provided charging stations as part of their service. Government incentives would also be very welcome.

Interview Summary for Fleet Number: 76

1. **Region:** Regional
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 4 Trucks
4. **Truck type(s):** Class 2b, Class 5, and Class 7
5. **Use-case(s):** Medium Duty (Delivery), Heavy Duty (Short haul, day truck), Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None, but they have one diesel hybrid

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: Top of mind for this fleet are *specialized vehicle specs* (e.g., refrigeration, "beer truck" spec), *fuel mileage*, and *build quality*. *Minimizing downtime* is key to their operation. *Emissions regulations* have driven retirement in the past. The barriers to electrification include *vehicle range*, *lack of infrastructure*, and *decreased delivery capacity*.

How are they used: The interviewee makes purchasing decisions but must send them to management for approval. Their approach consists of buying the best quality vehicles available, being very proactive with maintenance, and running them until their trucks fully break down.

Summary
Fleet 76 belongs to a craft brewery that ships throughout California and Arizona. The fleet has only refrigerated units: one van, two box trucks, and a heavy-duty (class 7) Peterbilt truck. The interviewee is the fleet manager and is responsible for purchasing vehicles. Decisions must be brought up to higher-ups for approval.

The fleet ranges in age from MY 2014 to 2019. The Ram Promaster was chosen because it was a high roof cargo van that could easily be retrofit to be refrigerated. The company worked with Isuzu to develop a specialized box truck that can also dispense beer from its side. They used to DIY the spec by drilling the side of a truck until they had a chance encounter with Isuzu employees and started the partnership. The company was offered the Hino 195 hybrid box truck and promised better than average fuel mileage. However, they found that the batteries to be heavy and their custom Isuzu ended up with better fuel mileage than the Hino hybrid. The interviewee is happy about the quality of Peterbilt trucks and would buy more in the future. Leasing did not make sense for the company because they would rather have a truck as an asset than not have a truck at the end of the lease.

They previously had a box truck that they had to retire because it did not have a diesel exhaust fluid (DEF) system. They ran it stationary as a refrigerator for a while until they sold it to a company in Chicago.

They keep their trucks until they become “mechanically unfeasible.” Each vehicle serves a different delivery purpose, so they replace them with similar vehicles at retirement. New trucks are preferred over used trucks as they come with warranties. They want a hybrid pickup truck but there is a long wait time. The interviewee sees used vehicles to skip the wait for a new vehicle. An external mechanic inspects used vehicles that are potential purchases. A mobile mechanic services the trucks every Friday to avoid having to send trucks into a repair shop and have downtime.

The company is expanding its capacity quickly and would like to create regional distribution hubs. Each hub would have a “beer spec” box truck and a driver. Because the company is based in California and does its own deliveries, even trucks operating solely in an Arizona-based hub would be subject to California rules.

Generally, they assign trucks to drivers, although drivers get some amount of vehicle choice. They had some issues coming out of the pandemic but have not been short drivers. Drivers do daily pre-trip inspections and liaise with the mobile mechanics but don’t track things systematically. The interviewee encourages company drivers to use biodiesel. Drivers have fuel cards.

The interviewee foresees the next change to be regarding transport refrigeration units (TRUs). Their TRUs are diesel-powered and run independently from the vehicles. These are being more tightly regulated by CARB. The interviewee hopes that if TRUs are eventually banned, there would be a clear transition period. The interviewee keeps track of regulatory information through quarterly CARB emails and relevant conferences.

The interviewee is not ready for EVs because they believe the range and infrastructure are not there yet. The weight of the batteries would decrease their cargo capacity. If there were suitable vehicles for their needs, they would have a big enough power supply to build the charging infrastructure.

Interview Summary for Fleet Number: 77

1. **Region:** Regional (California-focused but some in Reno, NV)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 14 Trucks
4. **Truck type(s):** Class 7 and Class 8
5. **Use-case(s):** Medium Duty (Delivery), Heavy Duty (Short haul, day truck, drayage)
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The main factors for purchase include *fleet consistency* (for ease of maintenance) and *vehicle availability*. Leasing is used to manage the company's *tax liabilities*. Retirement decisions are driven by *total mileage*, *emissions regulations*, and *maintenance costs*.

How are they used: The interviewee makes fleet decisions with the owner, who is also his father. They are open to some experimentation, and they react to market conditions by shifting business operations.

Summary
Fleet 77 is part of a trucking and warehousing company operating primarily in Northern California with limited operations as far as Reno. The interviewee is the owner's son, and they make all fleet decisions together. While the longest routes can be up to 400 miles, most drivers do port drayage and local delivery jobs. Trucks return to the depot every night.

The company buys new trucks from a Kenworth dealership in northern California. Since the pandemic, they have not been able to buy a truck. Even pre-pandemic, vehicle availability limited their truck choices (e.g., Paccar engines instead of Cummins engines). They want to stick to Kenworth and Peterbilt trucks because too many different trucks make for difficult maintenance. They keep a spare truck for when other vehicles need to be in the shop. The company has leased a few trucks over the years to manage its tax liabilities, as advised by its accountant. They have never rented.

When CARB phased out pre-2010 vehicles, the company received letters saying that they had to retire their trucks and were fined for not turning them over fast enough. Those old trucks were sold to a buyer in Mexico. Now, the fleet ranges from MY 2013 to 2018, and they get enough mileage to retire vehicles before they're out of compliance. The company weighs a vehicle's total mileage against its resale value to determine when to sell it. Their typical target is between 600,000 and 900,000 miles. Because of their experience with CARB, they would rather stay ahead of the regulations in the future.

The company has an in-house maintenance shop, but their mechanics are close to retirement so they may lose that in-house capacity and may therefore have to sustain a newer fleet. Their mechanics do everything except for warranty work. They would hire new mechanics if they could find skilled ones. They keep records of all expenses such as fuel, maintenance, licensing, etc., but they don't specifically track it by truck. At high mileage, their shop foreman may say certain repairs aren't worth it, triggering retirement.

They aren't particularly affected by AB 5 because all except two of their drivers (drayage drivers) are employees. The company has been dealing with a driver shortage for the past five or six years and has resorted to displaying billboards in addition to online job postings. There is no opportunity for driver feedback to influence vehicle purchasing because there are simply too few trucks available.

In terms of alternative fuels, the company buys renewable diesel because it is cheaper than regular diesel and burns cleaner, providing more life for their diesel particulate filters (DPFs). The company has explored natural gas as they have a large tank on-site. However, it would complicate operations by splitting trucks into diesel and natural gas. The interview sees electric trucks as several years away from viability due to the lack of charging stations, mechanics experienced in EV equipment, and unfamiliarity with performance. To make the switch, the interviewee says that CARB would have to build charging stations at no cost.

They are unsure about continuing to expand their trucking business in California due to the difficulties of operating in the state. The interviewee has been focusing more on warehousing instead. The biggest shift in the next few years is the inability to find trucks, which would push the company away from doing trucking altogether.

Interview Summary for Fleet Number: 78

1. **Region:** International (Mexico and southwest U.S.)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 200 trucks in both countries; 75 just in the U.S.
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul), Heavy Duty (Short haul, day truck)
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<u>Keywords</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: *Fleet consistency* (and therefore *brand loyalty*), *regulation compliance*, and *fuel mileage* are key fleet purchase factors. Turnover is driven by *total mileage*, *maintenance costs*, and *fuel mileage*. The interviewee is eager to implement AFVs, although *lack of NG fueling stations* and *lack of E-truck availability* were cited as barriers.

How are they used: The company focuses heavily on preventative maintenance and fuel mileage, which increases its ability to sell retired trucks. Fleet decisions are made by the interviewee with approval from the owner.

Summary
Fleet 78 belongs to a binational company operating in the U.S. and Mexico. The company performs general and intermodal shipping. The entire fleet is composed of 200 trucks, about 75 of which operate in the U.S. The interviewee is the company's safety manager and leads fleet decisions with the approval of the owner.

About 20% of U.S. fleet performs drayage. The company is waiting on an order of 30 trucks to expand its U.S. fleet. Beyond truck size and either a sleeper or day cab, most of the fleet does not differ in specs. The company likes to stick to International and Freightliner trucks with Cummins or Detroit engines because that is what the company and its mechanics are used to. They have good relationships with those brands, receive good after-purchase service, and find it easier to have interchangeable parts. To combat supply chain issues, they have been stockpiling spare parts. The entire fleet (in both countries) is compliant with California port regulations. Dealerships, even those on the Mexico side of the border, all have CARB-/port-compliant trucks because that's the market they cater to. The supply chain issues have delayed truck orders on both sides of the border.

For long-haul/OTR units, the interviewee prefers the reliability of new trucks. Trucks are moved to local operations at 400,000 to 500,000 miles. The company also buys used trucks (under 300,000 miles) to fill out the short-haul fleet. Their long-haul trucks tend to be Internationals, while short-haul trucks tend to be Freightliners. The fleet also has some trucks leased from Penske to avoid downtime. Because used trucks are currently expensive, they would rather order new and wait. For their U.S. fleet only, the company buys extended warranties. Companies providing extended warranties in Mexico avoid honoring the warranty.

Regular preventative maintenance service is done in-house, while warranty repairs are brought to the dealer. The company focuses heavily on preventative maintenance and fuel mileage. Their diesel department regularly checks each vehicle's mpg, while the shop sends out a notification if a truck is getting constantly being repaired. The company buys fuel in bulk for vehicles that return to their yard, while drivers on the road fuel up using Pilot fuel cards. All drivers are employees.

The company keeps trucks until 700,000 miles unless they become problematic and must be in service a lot, in which case they are retired earlier. They arrived at this figure by balancing use and resell value. They sell retired trucks to other fleets rather than dealerships to avoid dealership markups and because their trucks are in such good condition that they don't worry about finding buyers.

The interviewee is considering natural gas although they recognize the scarcity of NG fueling stations as a barrier. The company was approved for a $2 million Carl Moyer grant but had to back out when the NG fueling station provider fell through. The interviewee is more confident about electric trucks and has been in discussions with a contact within CARB. They are satisfied with the range of models in production, although they haven't been able to get one due to vehicle availability issues. If ZETs became available, the interviewee would install the required charging infrastructure.

Interview Summary for Fleet Number: 79

1. **Region:** Southern California
2. **Ownership Model:** Mixed (70% company-owned, 30% independent driver-owned)
3. **Fleet size:** 75 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Short haul, day truck)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** CNGs

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Brand loyalty*, *vehicle age*, and *incentive programs* are the major factors for purchase decisions. Turnover is driven by *maintenance costs*, and the available of *trade-in/incentive programs*. The interviewee cites *green marketing* as a benefit of operating alternative fuel vehicles, but notes that CNG trucks have *low reliability*.

How are they used: The company focuses on grant programs and has therefore been an early adopter of CNG vehicles. On the other hand, their reliance on grants results in keeping old trucks for a long time until they can trade them in through such programs. The equipment manager evaluates potential purchases, and the interviewee (CFO) approves purchases.

Summary
Fleet 79 belongs to a company performing container drayage operations out of the Ports of LA and Long Beach and up to 80 miles away. The interviewee is the CFO and makes all purchase decisions, with some input from the CEO and COO. The company's equipment manager advises on purchases and parts.

The fleet consists of company trucks and independently owned trucks; about 30% of their trucks are owned by independent contractors. The company typically buys new trucks only when it can access incentive programs to facilitate such purchases. The fleet has 10 CNG trucks acquired through an AQMD grant in exchange for retiring 10 diesel trucks. In total, they have 25 CNG trucks and are getting 5 more. The non-AQMD CNG trucks were bought used from a trucking company that happened to be selling them for an affordable price. The company also buys used diesel trucks that are five to six years old. The company prefers Freightliner trucks, but only occasionally works with dealers. They have seen used truck prices increase due to ongoing supply chain issues. The interviewee is not interested in leasing and prefers to buy used trucks as they can use them as Section 179 tax write-offs.

The company outsources maintenance. The interviewee notes that drayage trucks can have more maintenance issues due to high amounts of stop-and-go operations and hooking/unhooking containers repeatedly. Although they don't consider fuel mileage in purchase decisions, they track fuel costs for each truck.

When trucks require costly or repeated repairs, they are taken out of service. The company takes advantage of "trade-in" type programs to get rid of these vehicles. Because of this, though, they tend to hold on to old trucks and just let them sit in wait for another grant opportunity. These idle trucks can also serve as temporary replacements for trucks in the shop. Retirement is not based on a specific total mileage or age.

The interviewee is interested in electric and fuel cell vehicles, although they would only make the switch with the help of a grant program. The interviewee has other contacts in the trucking industry that have tried electric trucks as part of demonstration programs. Thus far, having CNG trucks benefits the company's marketing because clients are environmentally conscious. However, the interviewee would avoid CNG trucks due to the trouble they have with breakdowns and repair costs.

Two regulations will impact the company's operations soon: CARB regulations will make five to ten of the company's trucks and most of the independently owned trucks out of compliance; and AB 5 may require their drivers to become employees, meaning that the company will need to buy more company trucks.

Interview Summary for Fleet Number: 80

1. **Region:** Regional within California: Ports of LA and Long Beach
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 40 Trucks
4. **Truck type(s):** Class 3 and Class 4
5. **Use-case(s):** Heavy Duty (Short haul, day truck)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Fuel efficiency* (through lightweight specs), *brand loyalty*, and *total mileage* are key inputs for purchase decisions. *Port/emissions regulations* have been a driver of fleet turnover. The interviewee is optimistic about ZEVs but cites *vehicle range* and *unknown maintenance requirements* as potential hurdles.

How are they used: The company's focus on fuel efficiency leads it to source very specific trucks. They prefer to bring components such as vehicle maintenance and driver training in-house. The interviewee is pursuing ZEVs through an AQMD incentive program.

Summary
Fleet 80 belongs to a dry goods delivery company that is based in LA and operates at the Ports of LA and Long Beach. The interviewee oversees sales and operations and makes purchase decisions with their business partners.

The company has 40 trucks and 28 to 30 drivers, keeping an excess of trucks for redundancy. The trucks pull flatbed chasses that carry cargo containers. All trucks are day cabs with aluminum wheels and single fuel tanks; they make their vehicles as light as possible to maximize fuel efficiency. Generally, the company purchases either new trucks or used trucks with less than 300,000 to 400,000 miles. They have a few dealers who send them used day cabs they inspect. It can be difficult to find their ideal lightweight spec as most trucks are "fully loaded." The company rented trucks to fill in for extra demand but does not do long-term leases. Used trucks are around $100,000 and new trucks are only $30,000 or $40,000 more so it can be worth it to order a new truck. However, the tradeoff is that there is a long wait period for new trucks. The company previously ordered a yard goat, but their order was delayed due to the pandemic.

The interviewee prefers Freightliners with Cummins motors, as spare parts are readily available. They have one Mack truck but struggle to get spare parts or service because of the smaller network. A company was moving out of state and offered the interviewee low-mileage International trucks; they tried them out but found that the reliability was not as good as

Freightliner. Maintenance was brought in-house about five years ago and they implemented systems to increase communication between drivers and mechanics.

One truck was too old to be operated in the ports, so it was sold for parts in Central America. The interviewee plans on using an Air Quality Management District (AQMD) replacement program to get rid of old equipment and get new electric equipment. They have already been approved for the program but there have been delays. The interviewee believes that there will be a central charging station in the port.

Company drivers do two or three rounds per shift, doing routes up to 70 miles. The company trains prospective drivers in their yard until they are ready to get commercial licenses to go out into the field. This avoids difficulties with sourcing drivers as well as older drivers who have accumulated bad habits. Initially, it was hard to find insurance that insured such young drivers, but new, more flexible insurance companies have since entered the market.

The interviewee attends meetings at the port regarding port emissions. They also read the truck publications and stay up to date on equipment and the industry.

The interviewee is considering hybrid and electric technology. The interviewee anticipates electric trucks only being able to do one shift. Some of the company’s drivers are excited to try electric trucks; they are the same drivers who are keen on implementing other technology such as GPS or mobile apps. As for maintenance on electric trucks, they are unsure of what it would entail for their mechanic but are okay to learn along the way. They have one natural gas truck but struggle to find natural gas stations. In addition, the interviewee notes that autonomous vehicle technology may be available in 10 to 20 years.

Interview Summary for Fleet Number: 81

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 16 Trucks
4. **Truck type(s):** Class 8 (presumably)
5. **Use-case(s):** Heavy Duty (Long-haul, line-haul, Short haul, day truck)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Used only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Fuel economy* and *upfront costs* are weighed against each other in purchase decisions. Fleet turnover is driven by *emissions/vehicle regulations* and *market conditions* such as *fuel prices*.

How are they used: Fleet decisions appear to be done in a hierarchical manner, through the parent company and with approval from the owner. However, the interviewee describes the owner's decisions can made on a whim rather than through an analytical process. This fleet actively exploits loopholes to minimize costs and avoid regulations whenever possible.

Summary
Fleet 81 is comprised of 16 trucks that, while managed under the same California-based parent company, operate under three separate companies. This helps to isolate business risks (e.g., DMV holds) to portions of the company rather than all of it. Fleet decisions are made through the parent company.

The fleet is a mix of newer and older trucks. Other drayage companies deliver containers to a yard outside the port, which allows this company to finish the delivery without entering port facilities. The high cost and amount of paperwork required to operate in California ports is a major disincentive, even though some of their trucks could theoretically still enter the ports.

When choosing trucks, they balance upfront costs and fuel costs. While an older truck might be cheaper, it might have very low fuel mileage. Currently, the company is looking to buy 2018 models. The company owner makes the final decisions regarding truck purchases. The owner bought a Peterbilt which was premium quality, but the parts were expensive and it had poor gas mileage; they subsequently got rid of it.

The interviewee notes that the price of fuel has increased a lot, and they are receiving less revenue per load. Certain truckers are even defeating their truck's DEF to save money. They describe competition from recent immigrants who undercut prices. They save cost on insurance by carrying only liability insurance (as well as insurance on the loads the haul) but not on their trucks. Maintenance is done in-house by a company mechanic. The interviewee supervises the regular 90-day and annual inspections.

This company would run trucks for up to 30 years if it weren't for regulations. Thus, CARB regulations are the biggest driver of fleet turnover. Due to increasing costs, the company has also had to downsize. In the downsizing process, the company is trying to get rid of the older models that have lower fuel efficiency. However, they have also sold newer trucks as new as 2018. Retired trucks are sold online or by word of mouth through the trucker community. The latter tends to get higher prices for trucks (e.g., $45,000 through contacts versus $25,000 online).

The company utilizes for-hire drivers. The interviewee notes that since they are for hire, the drivers can pick and choose between routes. The company owner takes driver preferences into consideration to keep them happy.

Interview Summary for Fleet Number: 82

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 4 Trucks
4. **Truck type(s):** Class 5 and Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul), Heavy Duty (Short haul, day truck)
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Used only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Egalitarian
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: Factors influencing purchase decisions include *vehicle price and availability*, *maintenance costs*, and *fuel mileage*. The interviewee cites *potential future technologies* as a big influence on fleet turnover.

How are they used: Inputs are evaluated using a spreadsheet model; the model is combined with intuition to make a final decision, with input from another staff member. The interviewee is optimistic about clean fuel technologies: they are developing one of their own, would participate in EV pilots, and even hold off on turnover in case new tech becomes available.

Summary
Fleet 82 hauls general/dry goods within the contiguous 48 states. The company also serves as a driver association and is independently developing alternative fuel technology. The interviewee is the company's general manager and drives trucks. There is another staff member who inspects trucks and evaluates their viability.

They currently have four trucks, two of which are out of service for repairs. The two that are running are a 2014 Kenworth and a 2013 International. These trucks were chosen because they were available for a good price. The interviewee is brand-agnostic. The company started with one truck and has worked its way up to four. The company does not have a main hub for trucks; instead, trucks make stops at various locations. On an average day, a truck can go 675-700 miles.

The interviewee has a spreadsheet for evaluating a potential purchase. Factors include maintenance (e.g., oil and tire changes), fuel costs, estimated fuel mileage, and repairs. The interviewee uses conservative estimates for factors such as fuel mileage. When ultimately deciding, the interviewee combines the quantitative model with "gut experience." A similar process is used for retiring vehicles.

The interviewee wants to get the out-of-service trucks running again but may also convert them to a new technology being developed by the company. In the meantime, they are paid for, so the company doesn't mind hanging onto them for now. If no substantially new technology is available when their current trucks become ineligible to be registered, they will just buy two more used trucks. At the end of a vehicle's life, the interviewee would rather discard a truck than sell it to a potential competitor for a cheap price.

The interviewee is optimistic about zero-emission trucking and thinks that the technology is in place to make the transition feasible. They are interested in battery swaps as a solution to charging. They are developing an alternative fuel technology with a partner. They are also interested in biofuels such as hemp fuel.

The interviewee keeps track of CARB regulations but notes that there are consistencies with which emissions are targeted. The interviewee sees no problem with AB 5 but is putting together a leasing program to help independent operators access trucks without credit barriers.

Interview Summary for Fleet Number: 85

1. **Largest region over which fleet is operated:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 700 to 1000.
4. **Truck class(es):** Class 2b (many) through several heavier weight classes including five Class 8.
   Class 2b — 8,501 to 10,000 pounds
   Class 3 — 10,001 to 14,000 pounds
   Class 4 — 14,001 to 16,000 pounds
   Class 5 — 16,001 to 19,500 pounds
   Class 6 — 19,501 to 26,000 pounds
   Class 7 — 26,001 to 33,000 pounds
   Class 8 — 33,001 or heavier
5. **Use-case(s):** All use cases involve moving their own service personnel, vehicles, and equipment.
   Heavy Duty (Long-haul, line haul) → Interstate or Intrastate
   Heavy Duty (Short haul, day truck)
   Heavy Duty (Vocational with Power Take Off)
   Medium Duty (Vocational with Power Take Off)
6. **Buy or Lease:** Purchase only (Rent occasionally to fill in for an out-of-service vehicle.)
7. **Acquire new, used, or trucks in both conditions:** New only
8. **Hybrids or AFVs currently present:** Yes, Plug-in Hybrid Electric or Battery Electric, but light duty vehicles only.

<u>*Keywords*</u>
Adaptability: Reactive
Decision Making Structure: Group-Hierarchical
Complexity: Simple

Inputs to fleet turnover decision-making

Acquisition driven largely by **vehicle retirements** with occasional demand for additional (rather than replacement) vehicles. Acceptable manufacturers are **dictated by parent company** for light- and medium-duty vehicles. Heavy-duty vehicles appear to be determined less by these proscriptions and more by the specifics of each transaction.

Retirement: **Mileage thresholds**; vehicle specific. **Maintenance costs**.

How are these inputs used?

Vehicles approaching their mileage limits or reporting high maintenance costs are put on a list for potential replacement. That list is generated biannually by the Fleet Director (interviewee) with input from the division managers. Once the list is finalized, it is presented to company executives for approval. Interviewee exercises a great deal of control over the process. He suggests vehicles for replacement to division leaders more than they make requests to him. The higher-level decision makers who nominally have the highest level of authority have never (yet) contradicted his recommendations for truck replacement. Requests for additional trucks (that is, more trucks rather than replacements) generally come from division heads. With a demonstrated need to validate the acquisition, the decision is passed to company executives for their "approval." The interviewee claims he is directly responsible for all vehicle acquisitions and retirements.

Summary

The interviewee describes the company as an electrical engineering company. They provide a variety of energy (electricity) services to large commercial, military, airport, and other large entities. They do not serve residential energy. One division works on powerlines, acting as a sort of third-party vendor to electrical power companies. A construction division builds micro-grids and mobile generators. Service division provides technicians to work on these installations. Monitoring division provides remote monitoring. Energy Efficiency Services division installs energy efficient tech in buildings. They work on a national scale. Company was sold to a far larger energy company in 2017.

Interviewee is the Fleet Director. He states all vehicle acquisitions and retirements are handled by him.

Total fleet varies in size from 700 to 1000 vehicles. The fleet presently includes five Class 8 trucks, 50 "container chassis" trucks (of unidentified weight class but likely between 3 and 6), and "hundreds" of "service body" (I think these are cab-and-chassis) trucks upfitted with specialized equipment "such as you might see a phone company or utility" using. Construction division operates many F250, 350, and 450 trucks equipped for towing but not upfitted for specialized applications. (It seems likely some of these are Dodge RAM trucks based on spreadsheets and truck order templates the interviewee shared.)

The new parent company imposes a manufacturer requirement that appears to apply to light-duty and medium duty (2b) vehicles: Chrysler, Dodge, Ford. Interviewee cites examples of heavy-duty vehicles from other manufacturers: International (stake bed truck), Volvo (Class 8 "semi"); Isuzu box truck. He bought a crane truck for the Energy Efficiency Services division because they were moving into an activity that required such a truck.

Some vehicles assigned to drivers; some are in motor pools with no assigned drivers. Vehicles over 10,000 lbs. have electronic logs; drivers must log into system to get a vehicle. Employees within a division see only the trucks their division "owns."

Fleet management is done via a fleet management service company, Wheels. All data on trucks is entered into this service. Maintenance is coordinated by Wheels. Each truck contains information required for a driver (or someone else at each division) to take that truck to a third-party maintenance provider who then contacts Wheels with an estimate. Below some limit ($1,500), Wheels approves the service and records the expenditure. Estimates above the limit require the interviewee's approval.

Truck acquisitions appear to most often be prompted by a replacement for an existing truck. At one point he remarks they turnover about 20% of their vehicles each year. Biannually, he identifies trucks for possible replacement by monitoring the fleet through Wheels. His two determinants are miles and maintenance costs. He has mileage heuristics based on experience with trucks over the years. These heuristics may be as specific as a make/model of truck with specific engine types. For example, Ford F150s with turbo-equipped engines tend to blow their turbos between 120k and 150k miles. So, at 100k those trucks are put on the list to consider for replacement. (This gives lead time for the replacement to be purchased and delivered.) A Ford F450 with a diesel engine: 200k miles. A Class 8 truck: " a half-a-million miles." Maintenance costs are evaluated for being "high" or unlikely to be worth it given vehicle age or miles. A candidate truck might not be replaced but moved to a lower mileage application for a couple years, then retired.

Having identified candidates for replacement, interviewee consults with the division heads on the disposition of those trucks. With their concurrence, he takes that list to "company executives" for their decision. He says they have never contravened his recommendations.

For trucks for which many are likely to be purchased at a time, he builds a template. This is especially the case for upfitted truck; the template includes the chassis and upfit requirements. 12- to 18-month intervals he will discuss with field personnel whether the resulting trucks can be improved. This process produced, for example, a change in one of the templates to include a hose reel on the external fuel tank to make refueling from that tank easier and safer. He believes the truck users appreciate this opportunity to provide feedback. The template also ensures uniformity so people can't complain about someone else getting a fancier truck.

All trucks are purchased. Prior to being purchased by the new parent company all trucks had been leased. These leases are described as "open-ended" meaning they had no set term or miles limits. The new parent company is far larger than fleet 85 and with the additional available capital, fleet 85 now pays cash for all their vehicles.

Trucks to be retired are listed on a company portal for a month or so, giving employees an opportunity to buy them. The vehicles sold to employees generally do not include trucks with specialized equipment. The interviewee says that almost every time a specialty truck is sold to an employee, that person quits to start their own company. Vehicles are eventually sold at auction; the interviewee does not know who the buyers are.

The few light-duty electric vehicles (Tesla) he's purchased came at the direction of someone else in the company. He has not considered electric vehicles for any of the Class 2b and higher vehicles in their fleet. Some trucks sometimes drive too far; electric trucks' driving ranges are too short. Many projects are in rural areas without access to either charging or natural gas refueling.

Interview Summary for Fleet Number: 86

1. **Largest region over which fleet is operated:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 600
4. **Truck class(es):** Not clear what the largest vehicle is, though they have one 26ft. box truck which is likely a Class 6.
   - ❑ Class 2b — 8,501 to 10,000 pounds
   - ❑ Class 3 — 10,001 to 14,000 pounds
   - ❑ Class 4 — 14,001 to 16,000 pounds
   - ❑ Class 5 — 16,001 to 19,500 pounds
   - ❑ Class 6 — 19,501 to 26,000 pounds
5. **Use-case:** Medium Duty (Delivery)
6. **Buy or Lease:** Both Purchase and Lease (though presently moving to all leasing)
7. **Acquire new, used, or trucks in both conditions:** New only
8. **Hybrids or AFVs currently present:** No

Keywords
Decision Making Structure(s): Group hierarchical
Adaptability Keywords(s): Reactive
Complexity Keyword(s): Simple [Ken: with aspirations to be complex]

Inputs to fleet turnover decision-making

Usage (mileage); maintenance expense (> resale value)

How are these inputs used?

Even after re-listening, I'm not sure we know how decisions are made. Interviewee spends most of the time talking about how he'd like to be making decisions: data-driven TCOs. For now, they seem to be working without a "real replacement program" because of their inability to get new trucks. Interviewee identifies which trucks are candidates for replacement based on costs associated with unplanned repairs: repair costs, replacement truck rental costs, driver cots. The process does involve engaging regional managers in updating the upfit specifications for trucks. Interviewee can retire a truck on his own authority. Acquiring trucks requires him to create a capital request plan which requires approval by "management."

Summary
Fleet 86 is part of a health care services company. The fleet is used to deliver durable medical equipment, e.g., beds, hoists, lifts, wheelchairs, etc. This service is provided out of 120 locations across the country; recent expansion of 65 trucks and personnel throughout CA, OR, NV, and AZ. Hospitals and long-term facilities generally require larger, heavier equipment than home hospice. Further, because same-day delivery is often required, trucks also serve as "warehouses on wheels." A mix of vehicle sizes to meet these differing needs: vans (smaller Promax and larger Sprinters) and box trucks. About half the vehicles are box trucks (largest of which is a single 26ft truck which he wants to get rid of—doesn't want any trucks requiring a CDL). Shifting away from diesel toward gasoline over the past few years. Capital cost of diesel trucks is

much more ("$8,000), expensive and finicky emissions systems. More moving parts; more specialized and expensive maintenance. They do have different vehicles upfit in different ways with shelving and racks. (This limits their ability to use rental trucks.) Mix of trucks means part of their fleet is subject to US DOT regulation and some is not. He'd rather not be buying the Isuzu trucks (to keep trucks under 10,000lbs.). It would eliminate a lot of regulation and paperwork.

The interviewee is the Fleet and Safety Director. He claims a great deal of responsibility for fleet vehicle acquisitions and retirements. Fleet is centrally owned and managed. From his vantage point he monitors each vehicle. Used to manage fleet internally, but now have largely "farmed out" that work to an outside vendor/consultant (Mike Albert Fleet Solutions). Own about half the fleet; lease the other half. It seems though they are moving to all leasing—the trucks they own are older trucks they own. As those are retired, they are replaced with leased trucks. Though he notes trucks they purchased a few years ago as new can presently be sold for more than they paid—but he then refers to "renegotiating the leases" because of this situation.

He clearly thinks leasing is superior financially. Capital leases. Five years. 150,000 miles. "If we continue to pay them down to zero, then it's ours." If they do this, he notes they then must take over the registration and other costs, too.

"Fleet is finance." Work with finance team. At present, supply chain is a mess, so for now in most cases they are buying trucks at end of their lease and keeping them because they can't get new trucks now. Ordered trucks two years ago, has not received them yet.

Matching vehicle size to applications. Isuzu box trucks fits all use cases, but it is big, expensive to buy, expensive to fuel. However, it is not the best vehicle for all applications that don't require as big a footprint for the cargo area.

Choice of Isuzu—shape of truck has better maneuverability, Hino not available. He prefers some level of consistency across the fleet, but "…total cost of ownership is really the key." This leads him to want to downsize at least some trucks. Lower purchase price; more economical fuel use. Isuzus just went up in engine size. As they haul bulky rather than heavy loads, he doesn't need a more powerful engine. He is looking for the "biggest box on the smallest chassis that is still safe to run."

Re: TCO: *"We would like to be using that…We're just not organized and some of the data provided by the suppliers isn't as great as we would like it to be." "Data-driven." Installed GeoTab in trucks last year. Have lot of great data, but don't have it organized. "There's a story out there. What's the story? And we don't know…That's a big driver: total cost of ownership. And we'd like to know so we can make a better decision."* At this point, most of the data seems to be shared with Finance for forecasting, but it is not used to make specific decisions about acquiring and retiring trucks.

No direct feedback from drivers, but regional managers are included. He asks for input on the upfit design of trucks from regional managers, but the truck retirement decisions are made by him. A recent staff reduction was an "opportunity to liquidate." Truck usage data from GeoTab allows identification of under-utilized trucks to move to other applications. Other than that, they are not able to acquire new trucks because of supply problem. The fleet has never-the-less gotten about a year-and-a-half younger over the last two years as staff reductions have allowed them to retire some older trucks.

Previously, run trucks until they die. If a truck needed a repair which cost more than the trucks resale value, it would be retired. Truck at that point would likely be scrapped. If they have supply of new trucks coming in, they can retire trucks sooner, when the still have some resale value. Get quotes from Mike Albert for resale and from a couple different firms for scrap, then decide whether to sell or scrap.

Mike Albert Fleet Services is used to manage maintenance. Work is done by outside vendors, no in-house maintenance. Most locations only have one or two personnel total.

Lease trucks from Mike Albert; maintain trucks through Mike Albert; process truck retirements through Mike Albert (though they don't sell directly to Mike Albert).

He makes retirement decisions, but anything involve a new capital expenditure, i.e., leasing a truck, must go through several approvals, "there is a list of signatures." Annual capital request program is when he makes proposals to buy trucks. The request program may involve other departments requests too.

Only started collecting data necessary for TCO a couple years ago. Private equity thinks differently: If make this expenditure, when do I get paid back? Spends his time doing a lot of cost avoidance: renting a truck when a truck needs to be repaired. He can't yet figure out how to tell the story it is better to avoid those situations in the first place (by buying new truck) rather than rent a replacement, pay the cost of downtime of older trucks, paying drivers to make trips between repair shops rather than making deliveries and pickups . He just had a meeting with GeoTab and is still learning all the data that system provides. He notes, "we don't have access to other peoples' data…So we can' say, 'hey, look. There doing it this way.'" [Ken editorial: First mention I know of a fleet decision maker thinking about seeing data from other fleets.] He notes even their own data provider can't provide them with data from trucks in similar use in other fleets. He notes they [Ken: I think "they" is GeoTab.] won't provide him with a TCO, "They don't want to put it on paper."

Status: Alternative fuel curious. "Bottom-line is the dollars."

Interview Summary for Fleet Number: 87

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 120 Trucks
4. **Truck type(s):** Class 4, 6, 7, and 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul), Heavy Duty (Short haul, day truck), Heavy Duty (Vocational with Power Take Off), Medium Duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Complex

Inputs to decision-making: Although many factors are accounted for, the most prominent purchase factors are *local dealer support* and *service network*, particularly *quick maintenance turnaround*. Turnover is driven by *vehicle age* in conjunction with *total mileage* and *warranty expiration*. The barriers to adopting AFVs include *high vehicle prices* and AFVs being *unsuitable for their operations*.

How are they used: Factors are synthesized into a combined score that drives purchase decisions. Telematics and other software are used to collect data, although they stop short of calculating a TCO. The interviewee works hierarchically, pulling information from the maintenance and asset managers and forwarding it to superiors.

Summary
Fleet 87 serves the welfare program of a religious organization by transporting dry and refrigerated food items. It is a diverse fleet composed of vans, pick-up trucks, delivery trucks, grain and tanker trailers, flatbeds, tractors, and refrigerated trailers. The interviewee is the fleet manager for the organization. The interviewee works with a maintenance manager and asset manager to pull together information and send it up the decision chain.

The interviewee makes purchase decisions based on fuel economy, price, downtime, service network, local dealer support, driver acceptance, and comfort, among other factors. Factors are rated from one to ten and combined into an overall score for each OEM. Dealer support and service network are weighed more heavily in the analysis. The organization highly values being able to get trucks serviced with a five-day turnaround time. They typically select one primary vendor that gets 80% of their business and one secondary vendor that gets the rest. This approach gives most of the fleet consistency while allowing them to try different products. They have a good relationship with their primary vendor, which has allowed them to acquire vehicles even during COVID.

The organization has an in-house maintenance team. They track all maintenance costs using a data capture system that helps them compare costs between OEMs. Trucks are equipped with telematics software that helps the fleet manager track fuel mileage. They look at these factors separately, rather than combining them into a total cost of ownership. About 60% of their equipment is maintained in a central location. At other locations, they rely on maintenance agreements with companies such as Ryder and Penske.

The fleet turns over trucks at 500,000 miles (or 4 to 5 years) to avoid major repairs, although it differs by vehicle class. For class 6 trucks, they get retired around 200,000 miles, when their warranties expire. Some trucks get retired from their primary function and get repurposed for a secondary purpose (e.g., on a farm). The vehicles that aren't repurposed are sold through a broker or an auction. The interviewee reviews selling/retirement standards annually with an internal team.

The organization started using renewable diesel this year and is looking into hybrid vehicles. The interviewee sees electric trucks as too expensive and not suitable for their operations. Overall, they support lowering greenhouse emissions but also want to see electricity production become cleaner until they make the switch.

The interviewee tries to keep up with California regulations, sometimes with the help of OEMs. They also listen to a trade group's monthly report that monitors regulations within the industry.

Interview Summary for Fleet Number: 88

1. **Largest region over which fleet is operated**: Multi-state. Historically California only, but just opened a new operation in Phoenix, AZ
2. **Ownership Model:** Other. Mostly centrally owned. However, they do contract with third-party vendors to move equipment if that is cheaper.
3. **Fleet size:**15
4. **Truck class(es):**
   Class 6 — 19,501 to 26,000 pounds
   Class 8 — 33,001 or heavier
   The survey says Class 6 but throughout the interview he refers to trucks as "semis."
5. **Use-case(s):** Heavy Duty (Short haul, day truck) → Delivery
6. **Buy or Lease**: Purchase only
7. **Acquire new, used, or trucks in both conditions:** New only
8. **Hybrids or AFVs currently present:** No

Keywords
Decision Making Structure: Group-Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making

Non-routine maintenance cost, miles. Business expansion. Brand loyalty. Truck Availability.

How are these inputs used?

Replacement: When **maintenance cost** gets too high, trucks are sold to other companies or individuals, moved to a lower mileage application within the company, or sold at auction. Total miles is an indicator to start tracking a truck more carefully, but costs determine decision to retire.

For new truck purchases, added trucks are not evaluated differently than replacement trucks. Both will be either a Peterbilt or Kenworth. No special specification: all the trucks are the same. Especially now with the long wait times for deliveries of new trucks, they will buy the next available Peterbilt or Kenworth truck.

Summary
Fleet 88 uses their trucks to deliver their rental construction equipment to job sites. All trucks return to central location within the same day: "all our drivers spend their nights at home." Interviewee is company Controller. If a truck is to be purchased, he tracks "depreciation," though as he elaborates it is clear he is tracking non-routine maintenance and repair costs, on all trucks across all company locations. He will select trucks for retirement or shifting lower mileage application. For any given instance, he decides whether to pay cash or to finance, and if finance, from what institution. Decisions require approval of the company owners who he describes as "very hands on."

Brand loyalty is based on experience; he thinks both Peterbilt and Kenworth are similarly priced, similarly reliable and tend to have good, and similar, resale value. He doesn’t care about fuel economy. They don’t even track fuel expenditures for each truck.

In addition to operating their own fleet, they regularly hire third-party vendors to move equipment for them if it is cheaper or if they don’t have their own truck or driver available.

Maintenance cost is “100%” the determinant of when they retire a truck. Around a million miles “is typical on a semi.” However, it is cost not miles the is the final determinant. Will move a truck to another application with fewer miles or maybe sell it if they think it has better than average resale value. Auction is last resort. No reserve price for selling trucks.

Company does all its own maintenance. Uniform truck specification allows simplifying the stocking of parts for maintenance and mechanic training, but these effects is incidental.

No experience with alt fuels. No knowledge: no apparent desire to have any. This is likely to be a huge change in the next few years: “Shoved down our throats.”

Interview Summary for Fleet Number: 89

1. **Region:** Southern California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 170 Buses
4. **Truck type(s):** Class 3, 4, 6, and 7
5. **Use-case(s):** Passenger Transportation
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** Natural Gas

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: The key purchase factors are *vehicle availability* and *fuel type*. Fleet turnover is driven by *vehicle age/total mileage* and *maintenance costs*. *Regulations* and *administrative burdens* are moving the fleet toward AFVs.

How are they used: The interviewee is actively transitioning the fleet away from diesel and takes advantage of supporting grants. They make decisions with input from the shop manager.

Summary
Fleet 89 is a school bus company serving private schools and small school districts in Southern California, with routes up to 40 miles away from their yards. The interviewee is the owner/President/CEO and makes all final decisions with input from the shop manager on engine types and models. All drivers are employees.

Purchase decisions are based on the company's history with makes and models (e.g., certain engines have been problematic). They strive to maintain fleet homogeneity to make it easier to stock the same parts. However, these strategies are less workable now that buses are quite scarce. Currently, buses take up to twelve months to get delivered, which restricts the work that the company can do. There are also very few used buses available in the market. The company works with three dealers; there are only a few options for school buses that meet California standards. The company has some buses under a track lease, where the company can lease without putting the equipment on their balance sheets.

Retirement typically happens when vehicles are 19 to 22 years old (or approximately 400,000 miles) which is when engines tend to stop working or are too expensive to fix. The company received AQMD grants to install diesel particulate traps which extended the lifespans of some vehicles. Retired trucks are given to a company to salvage for parts and to scrap the rest.

As a privately-owned fleet with much smaller operations than the major carriers, the company must acquire service contracts before going to lenders and purchasing buses to fulfill those services. To stay competitive, the company targets small school districts and private schools that wouldn't be of interest to the larger carriers. They also offer different bus sizes and tailor services to client needs. Buses have gotten bigger as traffic has increased demand for school bus services. The interviewee also notes a shortage of bus drivers.

The fleet is transitioning away from diesel. Other than one diesel bus, the interviewee has only bought propane or CNG buses in the past eight years. The fleet currently has 19 CNG buses and 60 propane buses, and the rest are diesel. They are talking to Shell about creating an on-site CNG fueling station. Currently, they fuel their CNG buses at stations and their propane buses with a mobile propane fueling truck. The company does most repairs in-house but sends some repairs to the dealer.

The company has ordered four electric buses through a CARB program they have not arrived yet. Installing charging stations through the local utility will take a minimum of twelve to eighteen months, so they are looking into purchasing a mobile charging unit powered by propane. The interviewee notes that they support the transition towards electric buses but need places to charge them. Company drivers are very excited about electric buses.

The interviewee stays updated on incentive programs and says that government funds prioritize public entities that serve public schools, which presents a challenge for them as a private company. The interviewee gains information from industry magazines and conferences.

Interview Summary for Fleet Number: 90

1. **Region:** Northern California
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 52 delivery trucks, plus pickup trucks (unspecified number)
4. **Truck type(s):** Class 3 and Class 7
5. **Use-case(s):** Medium Duty (Delivery)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** Hybrid

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: The main factor influencing purchase is *dealer relationships*, followed by *vehicle reliability*, *capacity*, *range capability*, *ease of use*, and *maintenance cost*. Fleet turnover is driven by a combination of *total mileage* and *maintenance costs*. While a *lack of infrastructure* has hindered previous electrification attempts, *decreased fuel and maintenance costs* incentivize the interviewee to try again.

How are they used: The interviewee makes decisions with the approval of the general manager who is also the owner of the company. Vehicles are acquired annually, generally to maintain the status quo for the vehicle fleet.

Summary
Fleet 90 belongs to a food wholesale distributor operating in the Sacramento Valley. Almost all trucks are Class 3 and are used for local deliveries less than fifty miles in length. Two trucks are Class 7 and do longer deliveries. All trucks are refrigerated either by truck power or by a diesel generator. The company also has Ford pickups for employees. The interviewee is the assistant general manager and makes vehicle purchase decisions with the approval of the general manager/owner.

The fleet's Class 3 trucks are Isuzu NPR-XD. The interviewee indicated that a dealer relationship built on trust was key to choosing both Ford and Isuzu vehicles. Other purchase factors include reliability, useful lifespan, capacity, range capability, ease of use, and maintenance cost. The interviewee has been maintaining the fleet composition (just replacing them with the same vehicle model) because it has worked well for the company. The company does basic maintenance in-house and outsources other maintenance to a commercial vehicle shop. The fleet is large enough that there are spare trucks that can swap out for trucks in service.

Mileage triggers operational changes and retirement. Newer units are placed on longer routes and moved onto more localized routes once their mileage increases. A combination of high mileage and high maintenance costs or frequent breakdowns will trigger retirement. Vehicles are typically kept for ten to twelve years and run over 200,000 miles. Retired vehicles are sold into the secondary market through word of mouth. The pandemic and related supply chain issues have not had a great effect on fleet turnover because while vehicles take longer to purchase, their routes have also decreased. Out-of-compliance units can still be used in the cargo area as storage.

The company has not had issues finding drivers because all except two vehicles can be driven with a regular driver's license. All drivers are employees, and load and unload vehicles.

Through a program between the City and County of San Francisco and CARB, the company was interested in participating in an electric vehicle pilot. However, the program fell through due to a lack of infrastructure. The interviewee notes that there are electric vehicles available that suit the company's operations, and that they are interested in exploring electric vehicles again. Benefits cited include decreased fuel costs and decreased maintenance. They are not interested in CNG because of the increased difficulty of finding fuel. The interviewee tracks CARB regulations through industry news and CARB emails.

Interview Summary for Fleet Number: 91

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 21 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: The main purchase factor is *brand loyalty/fleet uniformity*, which stems from a good *dealer relationship*, *parts interchangeability*, and low *purchase and maintenance costs*. Retirement is driven by *total mileage*, *warranty expiration*, and *frequent/high maintenance costs*. A *lack of EV infrastructure* prevents the interviewee from considering EVs.

How are they used: The interviewee is the ultimate decision-maker for fleets, although they consult with the owner. Decisions are made largely through experience and long-term relationships with dealerships.

Summary
Fleet 91 belongs to a long-haul freight company based in Iowa operating across the country. The fleet is composed of 21 Freightliner reefers and van trailers. The interviewee is the vice president and is the final decision maker for purchase decisions, although they get input from their father, who is a part owner of the company.

The company keeps all Freightliner trucks (many of them the same model) so that parts are interchangeable, and for their low purchase and maintenance costs. They have been working with the same salesperson for fifteen years who knows the company's exact specs. All but one truck have sleeper cabs and do long-haul transport; the remaining truck does local short-haul routes. The fleet runs all Detroit engines because in their experience they are cheaper to work on and easier to get into repair shops over the road. Because the fleet hauls produce out of California, its whole fleet is compliant with CARB rules, including having DPF systems. Manufacturers typically produce vehicles that are CARB compliant. The company also has a safety director who keeps up to date on regulations and compliance.

On occasion, the company will buy totaled vehicles, rebuild them, and put them back in operation. This saves them about 60% over the cost of buying brand new. The company has never leased because it is more cost-effective to own vehicles.

The company does 90% of maintenance in its own shop and sends other work to the local dealership. Their head mechanic provides input on parts purchasing.

The company keeps trucks for an average of six to seven years. During this time, they may rotate higher-mileage vehicles for different uses. The ongoing supply chain issues have decreased the number of trucks they are able to purchase, which means that they will hold onto vehicles for longer. All new vehicles are purchased with five-year extended warranties (six years for the DPF systems). After the warranties expire, and if vehicles start having many problems, then they are retired. Retirements are triggered based on judgment calls based on experience.

Drivers are employed by the company and tend to work with the company for a long time. They have not had trouble with turnover or recruitment. Certain drivers refuse to drive in California due to its speed limits and traffic.

The interviewee has not investigated AFVs and sees electric trucks as unviable due to the lack of infrastructure.

Interview Summary for Fleet Number: 92

1. **Region:** California
2. **Ownership Model:** Mixed
3. **Fleet size:** 100 Trucks
4. **Truck type(s):** Class 2b-5: Class 7-8
5. **Use-case(s):** Medium-duty and heavy-duty delivery
6. **Buy or Lease:** Buy and lease
7. **Purchase condition:** New and used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Availability, dealership/ lessor relationships*, *fuel economy*, *and brand loyalty* for Hino are the primary acquisition determinants. Retirement is based on *total mileage, maintenance needs, and replacement availability.* They are receptive to electric trucks but don't believe there are any medium duty electric trucks on the market.

How are they used:

Fleet 92 leases approximately 40% of their trucks and purchases the remainder. They buy and lease "standard spec'd trucks" which facilitates resale. Truck availability is their biggest acquisition concern. To address availability concerns, they rely on the dealership and leasing company to provide innovative solutions such as lease extensions or long term-loaner trucks. The company has a long history with Hino trucks because of their reliability and durability and Volvo trucks because of strong fuel economy. Truck retirement is determined by mileage and maintenance. There are no hard triggers for retirement, rather these parameters are looked at in a general sense and compared to other trucks in the fleet.

Summary
Fleet 92 is used by a nursery to deliver horticulture and landscape products to retailers. They have a very diverse fleet with trucks ranging from pickups to class 8 tractor-trailers. Of the 100 trucks they operate, approximately 40% (primarily the larger trucks) are leased. Lease terms range from 60 to 84 months. Operations are limited to California but may expand to Oregon in the future.

Along with the interviewer (fleet manager), the CEO and CFO are involved in new vehicle acquisitions. The interviewer's familiarity with the fleet seems to be the deciding factor for determining truck replacement. Turnover is driven more by heuristics than analytics. However, the CFO provide cost information when needed and CEO approval is required for acquisitions.

Fleet 92 uses trucks from Hino, Volvo, Isuzu, and Freightliner. Most of the medium-duty trucks are Hinos and the heavy-duty trucks are primarily Volvos. The fleet is loyal to Hino because of a long history of positive performance and durability. They started using heavy-duty Volvos trucks because they believe the fuel economy is better than other available options. Most of their trucks are purchased with a “standard specification” which facilitates resale. It also makes truck selection simple and straightforward. Truck availability is now their biggest issue which they are addressing by holding onto assets longer and working with the leasing companies and dealerships to find alternatives to new truck purchases.

As trucks age and mileage accumulation increases, they are placed into less demanding applications. The interviewee looks at mileage and maintenance in tandem to determine when to retire a truck. However, there is no predetermined trigger for retirement but rather a general sense of when maintenance requirements render a particular truck “a problem child”. The inconvenience of frequent repairs seems to be as much of a retirement determinant as maintenance cost.

Fleet 92 has a relatively small operating area (primarily central California), so all trucks return to a specific location each day. Minor maintenance is done in-house by a mechanic who travels to the different fleet facilities. Major repairs are performed by outside shops or the leasing company. However, fleet 92 will perform minor repairs on leased trucks for convenience and to minimize down time. The fleet does not buy extended warranties. They dispose of some trucks through auctions, but most are returned to the dealership to sell.

The interviewee claims to be excited about the prospect of buying or leasing an all-electric truck. However, he is not aware of any medium-sized electric box trucks in production. They do operate a few hybrid electric, medium-duty Hino trucks.

Interview Summary for Fleet Number: 93

1. **Region:** Southern California
2. **Ownership Model:** Centrally-owned
3. **Fleet size:** 18 Trucks
4. **Truck type(s):** Class 6 and Class 7
5. **Use-case(s):** Medium-duty delivery/ Heavy-duty short haul
6. **Buy or Lease:** Buy
7. **Purchase condition:** New and used
8. **AFVs:** None

Keywords
Decision Making Structure: Hierarchical
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: *Dealership relationships*, *fuel economy*, *brand loyalty, and availability* are the primary acquisition determinants. Retirement is based on *total mileage, maintenance needs, and incentive funding availability* for destroying older high-polluting trucks.

How are they used: Fleet 93 prefers Freightliners and has a good relationship with the Freightliner dealership. However, they also purchase trucks through internet searches. Fuel economy is a purchase determinant but only to the degree of deciding between truck sizes. Purchase decisions are made almost intuitively based on the fleet managers vast experience and gut feeling. Fleet 93 keeps maintenance records but seldom uses the information. They do have a general idea of how much they pay each month for maintenance per vehicle. High mileage vehicles with maintenance costs exceeding $1000 - $2000 per month become candidates for replacement. However, Fleet 93 often holds onto vehicles beyond there optimal performance window to take advantage of CARB programs that pay for the destruction of older high-polluting trucks. CARB emission regulations also factor into truck retirement decisions.

Summary

Fleet 93 is a family business that delivers food products to restaurants. Deliveries are daily and trucks return to the warehouse at the end of the day. Because they deliver to several take-out pizza establishments, they experienced a boost in business resulting from the pandemic. All their trucks have refrigeration units, and two have recently been equipped with solar panels as part of a demonstration project. In the past they also collected used vegetable oil from their customers and turned it into biodiesel fuel, but it proved to be too labor-intensive, so they discontinued the practice.
The interviewee was new to fleet management and just learning about the position from his father who is in the process of retiring. His father has been the primary fleet decision-maker for 35 years, and he makes decisions based on "experience" and "intuition". In describing how his father made fleet purchase decisions, the interviewer explained:

> *He doesn't like to deal with paperwork or calculations. [He has] figured out which trucks he likes. He found a company that he*

likes, and he doesn't like change. We know what we're going to get. He says this truck is new. The cost is good. It has a lift gate and a reefer unit on it. If it checks off the boxes, it's good.

There is no reason to believe that the interviewee will deviate from his father's approach to fleet management. Fleet 93 keeps trucks no longer than 5-7 years, in part, to present a good public image. Also, their drivers do not like to drive older trucks. They like Freightliner trucks and have a good relationship with the Freightliner dealership; however, they do own other truck types that earned a place in the fleet through trial and error. In addition to the dealership, they search the web for good deals on new and used trucks. They consider fuel economy when purchasing but only in the context of whether to buy a tractor trailer or a smaller bobcat-style truck. They do not lease trucks because they feel that purchasing is cheaper overall (at one time the CEO wanted to switch entirely to leased trucks and requested that the fleet manager provide proof that purchasing was less expensive than leasing).

Although Fleet 93 has software that keeps track of how much they spend on individual truck repairs, they "don't really use that data". As the interviewee explained, "in a given time span of maybe three months, if that same truck has a problem every week, you don't really need to look at the money to know that it's a problem". However, they do look at their repair data occasionally to see what "a problem truck is actually costing them". They also know they average about $1000-$2000 dollars per truck on maintenance each month. Once maintenance starts to exceed $3000/month, they start considering replacement.

They do not have in-house maintenance but use one mechanic almost exclusively. However, about 25% of repairs must be done through the dealership or elsewhere. They keep a spare truck to substitute during repairs and rent additional trucks, if necessary. They do not purchase extended warranties.

When it's time to get rid of a truck, they have "a guy" that they use. The interviewee was not sure where the retired trucks end up but believes they are exported to Mexico.
Although mileage and maintenance trends are vague determinants for truck retirement, CARB programs also factor into the decision in a significant way. Fleet 93 will hold onto vehicles beyond their useful life to take advantage of forthcoming incentive program funding (specifically, programs that pay to destroy older high-polluting trucks). Because new acquisitions replace disposed vehicles, this practice presumably affects the entire turnover cycle. Fleet 93 has taken advantage of several incentive programs and proactively looks for the next incentive funding opportunity. They are also keep apprised of CARB emission regulations and plan turnover to avoid mandatory truck retirement.

Interview Summary for Fleet Number 94

1. **Largest region over which fleet is operated:** International: US and Canada
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 33
4. **Truck class(es):** Class 8
5. **Use-case(s):**
   Heavy Duty (Long-haul, line haul)
   Heavy Duty (Short haul, day truck)
6. **Buy or Lease":** Purchase only
7. **Acquire new, used, or trucks in both conditions:** Both new and used
8. **Hybrids or AFVs currently present:** No

<u>*Keywords*</u>
Decision Making Structure: Group, Hierarchical
Adaptability: Reactive
Complexity: Simple

Inputs to fleet turnover decision-making

"Quality": Reliability, durability, appearance.

Driver satisfaction.

How are these inputs used?

Arguments for buying only two makes of trucks (Peterbilt or Kenworth) are stated in terms of brand reputation and loyalty. There is no discussion of a systematic, quantitative comparison to other trucks, e.g., Freightliner is simply dismissed as "cheaper," not lasting more than a couple years. Rather, the company appears to be fulfilling a template for truck purchases. The interviewee, the truck supervisor, and the VP of Logistics (interviewee's immediate boss) work together to put together offer package for a specific truck; this package must be approved by company owner.

Driver satisfaction is important to driver retention; interviewee says all drivers hired since he started work are still with the company. The company invests in cleaning up trucks it buys used, repainting to maintain consistent appearance. Buys only trucks with manual transmissions because drivers are said to like them more than automatic transmissions.

Summary
Company provides repair and recycling services for jet turbines, e.g., the "engines" of commercial airliners. The company picks up and delivers turbines from locations across the US and Canada in trucks it owns and operates. The company is headquartered in Florida; this is also where its repair facilities are located. The interviewee works within the logistics operation to move turbines about the country.

Turbines are moved on or in a variety of trailers—flatbeds, dry vans, step downs. All tractors are Class 8. New (or newer) trucks are equipped with large driver-sleeper compartments to facilitate trans-continental trips. As trucks accumulate miles, they will be shifted to "local" services, i.e., within-Florida only. At that time, the sleepers are removed and the trucks are essentially converted to day cabs.

The company has not fully retired any trucks yet.

Purchase price is mentioned as a factor in the search for a truck to buy, however it appears secondary to brand, engine, transmission, and overall condition. That is, the company has decided what trucks it wants, then searches for matches and compares prices.

Interview Summary for Fleet Number: 95

1. **Region:** Western United States
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 21 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Both purchase and lease
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Proactive
Complexity: Simple

Inputs to decision-making: For purchases, the company focuses on *brand loyalty*, which stems from *dealer relationships*. They also aim for low-mileage vehicles to avoid coming up against *emissions regulations*. Retirement is driven by *high maintenance costs* or a *total mileage* threshold, whichever comes first. The interviewee cited many factors for not adopting electric vehicles, including *high purchase costs*, *insufficient battery range*, *battery weight*, and the *lack of robust maintenance and charging networks*.

How are they used: As a co-owner of the company, the interviewee makes all major fleet decisions. They are proactive in fleet turnover and make heavy use of heuristics gained from years of experience.

Summary
Fleet 95 belongs to a regional freight company that operates in the western United States. Routes typically take half a week to complete; all trucks are equipped with sleeper cabs. The interviewee is one of the company owners.

The company only has International trucks, some of which are ProStar models and others LT models. 15 International LT trucks were bought used from auction houses between 2020 and 2021 as part of a major expansion. The choice of International stems from the local availability of dealerships, good dealer relations, and good “middle of the road” value. They are a premium member with Ritchie Brothers. With increased prices in 2022, however, they are not currently buying trucks. The company used to lease new trucks from Penske, but they have since stopped because they were unhappy with their maintenance service. The interviewee would lease again, but only for short-term needs.

The company has an in-house shop for basic service and maintenance. They send trucks to a local International dealership for bigger repairs and breakdowns. Since the pandemic started, it has taken more time (up to five weeks) for trucks to get repaired. For this reason, the company keeps two trucks unassigned to fill in for trucks out of service. The company tracks maintenance costs, with a benchmark of $8,000 yearly for new trucks and $20,000 yearly for older trucks. They also track how often trucks are in the shop.

Retirement is driven by high maintenance costs and/or high total mileage. The interviewee retires trucks after 700,000 miles, regardless of whether they still run well. With all the emissions control systems in place, the interviewee sees many trucks not make it to that mileage mark. If a truck needs an engine rebuild, the company retires it.

The company's drivers are all employees. They drop trailers they deliver so that they do not have to load or unload the freight within. The interviewee prioritizes driver retention through good communication and truck amenities like refrigerators and microwaves.

All the company's trucks are CARB-compliant. The interviewee notes that the sweet spot for buying trucks that are fully compliant with CARB regulations is 200,000 to 300,000 miles and two to three years old (editor's note: unsure which of CARB's regulations this meets).

The interviewee does not see electric trucks as compatible with their company yet, owing to their high purchase prices, insufficient ranges, expensive per-hour rates for electric-certified mechanics, their increased weight, and the lack of charging infrastructure and parking. They also note that they would have to rebuild their knowledge base with brand-new technology, wiping out years of experience with diesel engines.

Interview Summary for Fleet Number: 96

1. **Region:** Regional (North Central California)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 20 Trucks
4. **Truck type(s):** Class 4 and Class 8
5. **Use-case(s):** Heavy Duty (Vocational with Power Take Off)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>*Keywords*</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Brand loyalty* and specific *operational requirements* prompt specific purchase specs. Retirement is driven by *total mileage*, *maintenance costs*, and *overall wear and tear*. The interviewee cites a *lack of charging infrastructure* and *insufficient range* for their mountainous routes as barriers for electrification.

How are they used: The interviewee relies heavily on experience and proven reliability. They do not like to experiment with truck specifications or AFVs. However, driver and mechanic input are accounted for to continuously improve specs.

Summary
Fleet 96 is a regional carrier of rocks, asphalt, and other landscaping materials near Placerville, CA. They perform for-hire and private work, with no overnight routes. The Class 8 trucks are dump trucks for hauling material, while the Class 4 trucks (Ford F450s) are used for temporary fence rentals. The interviewee is the president of the company.

The company used to buy used over-the-road trucks and convert them into dump trucks. They then took part in the Sacramento Emergency Clean Air Transportation incentive program and now prefer buying new vehicles because they can ensure that their engine and other vehicle specs are compliant with regulations. They run Kenworth trucks with Cummins engines to maintain a homogenous fleet and make it easy to stock parts. The interviewee stuck with Kenworth after a good initial experience. However, the interviewee notes that new vehicles nowadays don't last as long as old used trucks. They are also less customizable because there is much more technology embedded. The company's drivers appreciate the new technology and comfort of new trucks. Drivers and mechanics provide input about vehicle specs.

The company has its own shop with four mechanics and tries to do all work there unless it is warranty work. Trucks are purchased with extended warranties, which typically run out before trucks are retired. When trucks are down, they can't rent replacement vehicles because their equipment is specialized. They may utilize other carriers to fill any gaps. They used to be able to fill in more gaps with owner-operators, but there are not many left due to AB 5. The company uses cost-tracking software developed specifically for the dump truck industry. While they track maintenance and parts, they don't require very formal documentation because the fleet is small enough that the mechanics know each truck well.

The company starts to consider retiring dump trucks when they near 350,000 miles. They also consider other factors, such as maintenance costs and wear and tear from driver use. Retired vehicles are sold whenever possible to maximize their value. They are only scrapped when they are wrecked. The Ford F450s are turned over before 200,000 miles.

The interviewee tracks CARB news closely and is part of many industry associations. However, they are not interested in experimenting with new kinds of vehicles or AFVs. They prefer a proven power train. The interviewee also does not see the infrastructure and range being there yet for electric trucks.

Interview Summary for Fleet Number: 97

1. **Region:** Regional (Southern California)
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 12 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Short haul, day truck)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** Both new and used
8. **AFVs:** None

<ins>*Keywords*</ins>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: Purchase factors for used trucks include *total mileage*, *maintenance history*, and *past usage*, with *dealer relationships* and post-purchase services valued. Retirement is driven by *emissions regulations*; otherwise, trucks are run until they can't function. The interviewee does not like AFVs due to *distrust* and perceptions of *inferior performance*.

How are they used: The interviewee makes all fleet decisions for the company. Decisions are typically ad-hoc and situational.

Summary
Fleet 97 belongs to a logistics company based in Southern California. The interviewee is the owner and sole decision maker, although the company is under his father's name.

The fleet is composed of Kenworth, Freightliner, and Volvo trucks. The Kenworth trucks were bought new, but the rest were bought used. They typically buy used trucks below 500,000 miles, and they focus on vehicle history and past usage. The interviewee finds vehicles through dealers and through Facebook marketplace. Currently, new truck prices are too much for the company's budget. However, the company's operations are composed of small, steady contracts, so they haven't had to expand. The lack of trucks has also led the company to change to purchasing automatic transmissions, which are the only ones available. The interviewee doesn't purchase extended warranties but highly values dealer relationships.

Company drivers are mostly W2 employees, although they contract a few owner-operators with their own operating authority and insurance. They made this transition several years ago. Drivers provide feedback that informs fleet decisions, such as when they have difficulty using the clutch of a certain truck model. The company has a basic in-house mechanic and has a good friend who works on his trucks. Similarly, mechanic feedback can inform decisions (e.g., the Kenworth trucks had software that was difficult to work with). The interviewee keeps detailed records of every vehicle expense in a binder for each truck. It helps track costs and provides additional resale value to future buyers.

The interviewee has four 2008 trucks, which are set to be unregistrable next year. They will still try to register them but have spare trucks in place in case they are denied registration. The interviewee keeps trucks for as long as possible unless there is a major accident, in which case they sell the truck. They sell privately through personal connections.

Regarding AFVs, the interviewee does not want to switch away from diesel:

"I'm diesel forever. When they say [diesel is] done, then my time is done with the industry."

They believe that LNG and propane trucks lack power. They also do not understand the purpose of DEF systems; to them, they are useless filters that just keep breaking and costing money.

Interview Summary for Fleet Number: 98

1. **Region:** National
2. **Ownership Model:** Centrally owned
3. **Fleet size:** 25 Trucks
4. **Truck type(s):** Class 8
5. **Use-case(s):** Heavy Duty (Long-haul, line haul)
6. **Buy or Lease:** Purchase only
7. **Purchase condition:** New only
8. **AFVs:** None

<u>Keywords</u>
Decision Making Structure: Sole
Adaptability: Reactive
Complexity: Simple

Inputs to decision-making: *Reliability*, *dealer relationships*, *fuel efficiency, driver comfort*, and *maintenance* have led to *brand loyalty* for Volvo for purchase decisions. Retirement is primarily based on *total mileage*, although *market conditions* and *maintenance costs* are taken into consideration. Electric trucks may result in future *fuel cost savings* for the company, but the current *range limitations* do not work for them.

How are they used: The interviewee relies heavily on in-house data collection and business experience to drive decisions. Due to the company's long-haul operations, they focus on the reliability and longevity of their trucks. The interviewee has a maintenance team that advises but is the final decision maker for the fleet.

Summary
Fleet 98 belongs to a company delivering goods (mostly produce) between California, Massachusetts, Florida, Texas, Arizona, and Utah. The interviewee is the final decision maker, although the maintenance team provides input. Their longest routes can take between ten to fifteen days, although drivers can get sent to the closer states if they need to be back earlier. The company keeps three or four trucks in the yard for local work.

The fleet is composed of 90% Volvo trucks with a couple of Kenworths and Freightliners. The interviewee notes that consistency, dealer relationships, fuel efficiency, driver comfort, and maintenance are factors that affect brand choice. With the pandemic-related availability issues, they are more likely to try other brands. In the interviewee's experience, Volvo trucks remain dependable even after 500,000 miles. Volvo trucks are also comfortable for the company drivers, who are all employees. The interviewee has experienced a driver shortage that limits the number of trucks they can operate.

Minor maintenance is done at the company yard, but everything else is done through the dealer. Through Volvo connections, the company buys special warranties of up to 650,000 miles for each vehicle. The diesel exhaust fluid (DEF) system requires a lot of repairs and causes many breakdowns in the fleet. The interviewee tracks data for all expenditures for each truck.

Trucks are retired between 500,000 and 750,000 miles, sometimes with some warranty left in them. Nowadays, the company holds onto trucks for longer. Retired trucks get returned to the dealership; the interviewee does not want to spend time selling trucks. According to the interviewee, the buyers of these trucks tend to be owner-operators who do local routes.

The interviewee keeps up with the electric truck industry but does not actively pursue alternative fuels. As their biggest expense is fuel, they see value in the cost savings from switching away from diesel. However, since they do long-haul transport, they don't see the technology being there yet.

The interviewee relies mostly on experience and data collected through the company to fuel decisions. They are critical of information from others and insist on understanding the underlying reasoning and data.