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Economic Evaluation of Route Choice Characteristics for Company Truck Drivers and Owner-Operator Truck Drivers in Southern California Freeways

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16. Abstract

To contribute to the understanding of freeway capacity and financing options, this study evaluates the demand for truck-only toll lanes on Southern California freeways. The study implemented surveys to both company truck drivers and owner-operator truck drivers to estimate the value they place on time, reliability, and safety measures. The research team met face-to-face with both types of truck drivers near the Ports of Los Angeles and Long Beach to understand the drivers' perspectives regarding truck-only toll lanes on Southern California freeways. A data set containing 45 surveys out of 62 survey responses were used for statistical analysis. The results showed that the tolerated toll fees that both types of truck drivers combined were willing to pay ranged from $3.27 an hour to $41.45 an hour with an average of $20.50 an hour during weekdays, while those fees ranged from $3.04 an hour to $36.12 an hour with an average of $18.12 an hour during weekends. Both types of truck drivers are unwilling to pay toll fees for the routes used in six comparisons out of nine, despite sharing a common origin and destination. Data shows that, regardless of ownership type, both types of truck drivers similarly value a route with truck-only lanes. The highest toll fee per mile on any day that drivers are willing to pay when the main factor being compared is value of travel time (VOT) is $0.54 per mile or $32.38 an hour. The figures for the value of reliability (VOR) and safety measures are $0.47 per mile or $15.76 an hour and $0.17 per mile or $9.80 an hour, respectively. The VOR is important because it helps shippers and freight carriers make predictable travel times to remain competitive. These results are meaningful for legislators and transportation agencies because the behaviors and route choice characteristics of both types of drivers help them better reduce scheduling costs, understand the utility and demand for truck-only toll lanes, and resolve traffic congestion in the study area.

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Executive Summary

The authors aim to contribute to the existing literature on the economic feasibility of a truck-only toll lane. This research project focuses on the values of truck drivers, both owner-operator and company truck drivers. First, the authors conduct a literature review that discusses the wages of truck drivers in various countries and the means of data collection across many studies. Then, the authors implement the stated-preference survey to estimate the value placed on time (VOT), reliability (VOR), and safety factors by both owner-operator and company truck drivers regarding travel routes by using various scenarios geared towards assessing the values on Southern California freeways. In doing so, the authors met face-to-face with owner-operator and company truck drivers for an interview survey using structured survey forms. We collected complete sets of 45 surveys near the Ports of Los Angeles and Long Beach to understand the drivers' perspectives regarding truck-only toll lanes on Southern California freeways. Statistical analysis is then carried out on the responses, which provide information on the toll fees the truck drivers would tolerate on truck-only toll routes in various scenarios.

Both owner-operator and company truck drivers would tolerate a tolled truck-only lane, but how much of a fee they would tolerate varies by route. The responses showed that the tolerated toll fees range from \$3.27 an hour to \$41.45 an hour during weekdays, while those fees range from \$3.04 an hour to \$36.12 an hour during weekends. The tolerated average toll fees are \$20.50 an hour and \$18.12 an hour for weekdays and weekends, respectively. The analysis results showed that both owner-operator truck drivers and company truck drivers had different preferences regarding truck-only toll lanes when choosing a route with two different characteristics. From this result, it cannot be concluded that owner-operator truck drivers and company truck drivers will take truck-only toll lanes because they consider the tradeoff between value of time, value of reliability, and safety factors to be salient. We do not have enough evidence to reject the null hypothesis that owner-operator truck drivers and company truck drivers will take truck-only toll lanes regardless of their characteristics when they analyze a specific route. The results also showed that when comparing VOT and VOR by toll fee per mile, VOT (\$0.54 per mile), and VOR (\$0.47 per mile), drivers value time and reliability similarly. However, when the values are calculated by toll fee per hour, VOT (\$32.38 an hour), and VOR (\$15.76 an hour), the results indicate that the driver's willingness to pay for time is approximately twice the value for reliability. These results indicate that from the same point of origin and destination, truck drivers showed a similar willingness to pay for time and reliability. Of the three key comparison factors, in terms of toll fee per mile, drivers are least willing to pay for tolls when using safety as a key comparison factor and most willing to pay when considering the time factor to be the key comparison factor. In all cases, drivers' valuations of the time savings outweigh their valuations of reliability and safety.

1. Introduction

A route choice preference study, used in this research, is one of the demand analyses processes which determines the number or percentage of preferences between truck routes indicated by both company truck drivers and owner-operator truck drivers. The selection of truck routes is an intricate process, depending on factors such as the truck operator's income and the availability of transit services. Route choice depends on each route's advantages based on the convenience of travel, safety regulations, comfort, cost incurred, and travel time to the destination. The route choice assessments presented in this research aims to reflect the pertinent characteristics of truck drivers, the system of transportation, and the trip itself. A study of the economic feasibility of a truck-only toll lane considers the value of the travel time of truck drivers and needs to be analyzed beyond an academic discussion.

Owner-operator truck drivers are drivers that own the truck with their own means, either by leasing, renting, or buying. They operate a vehicle that is not part of or owned by another entity. Owner-operator truck drivers have an independent business and are in charge of managing all operations, finance, logistics, and legal requirements to operate a truck. They select projects and haul freight, and they can work with shippers independently and directly or work with a third-party broker who can liaise with shippers on their behalf. The second type of drivers, classified by ownership type, are company truck drivers. They are designated as employees of a company, and their main assignment is to operate trucks that are owned by the company. The company is in charge of contacting shippers, assigning load to a specific truck, planning routes and logistics, and assigning a truck driver from the company to move the haul. Owner-operators and company truck drivers have different work responsibilities as owner-operator truck drivers have more assignments than only driving the vehicle; they have a different perspective regarding tolls, time, safety, and variability of time, as any of these factors will directly affect the economy of their business.

This research is implemented based on the PI's recent MTI project that presented an estimation of the values that owner-operator truck drivers placed on time, reliability, and safety factors (Kim et al. 2021). The main objective of this research is to implement surveys and interviews in the field using the stated-preference (SP) method to examine the value of travel time (VOT), value of travel reliability (VOR), and the value of safety factors of both owner-operator truck drivers' and company truck drivers' travel. The value of time (VOT) is defined as a monetary value that truck drivers are willing to pay to reduce travel time. The value of reliability (VOR) is defined as the monetary value that truck drivers are willing to pay to assure that the estimated arrival time to their destination is reliable and with minimal fluctuation. Additionally, the value of safety is defined as the monetary value that truck drivers are willing to pay for a truck-only lane that minimize safety hazards, such as passenger vehicles not driving in the same lane as trucks and road conditions appropriate to variable weather.

The outcome of this report will present a more comprehensive analysis of shipper responses to travel time reliability than those available in existing studies. To achieve this, the research team designed and collected stated-preference survey data from truck drivers, specifically those who are owner-operator truck drivers, company truck drivers, and whose origin is the Port of Long Beach or the Port of Los Angeles, when they are deciding which route to take. The findings can be used in assessing the economic feasibility of truck-only toll lane development associated with truck traffic patterns. Understanding the difference between the value of goods and the wage of truck operators is critical for developing new strategies and incentives for transportation agencies to better manage highway systems.

2. Literature Review

Table 1 presents the estimated values of time collected from different authors. The table includes the estimation methods, VOTs, and driver types. The column heading *Method* describes the analysis method utilized for the data based on the wage rate (WR), marginal rate of substitution (MRS), and logit model (LM) methods. The column heading *VOT Original Date* describes the value of time determined by each author after its pertinent analysis. The column heading *VOT 2022* describes the same data converted to current values after applying the inflation rate in the year 2022 for the corresponding country of research. The column heading *Driver Type* describes the type of driver that was analyzed and the methods of data collection. The type of driver includes owner-operator (OO), company driver (CD), owner-operator of private fleet (PF), regular commuter (RC), and all types of truck drivers (ATD).

Table 1. Cases of VOT Estimation by Driver Types

Nation	Reference	Method	Data/Year	Variable	VOT Original Date (USD/hr. unless otherwise stated)	Driver Type (data recollection method)	VOT 2022 (USD/hr.)
USA	Kawamura (2000)	MRS	SP 1998/99	Transport time, toll	23.40–26.80	OO—PF 56%, CD 44% (in-person survey)	40.25–46.09
	Carrion and Levinson (2013)	MRS	2012	Travel time, toll cost	7.30–7.92	RC (in-person survey)	9.28–10.07
	Brownstone and Small (2005)	MRS	RP 2005	Traveler, toll, travel time	20.00–40.00	RC (phone survey)	30.33–60.66
	Lam and Small (2001)	WR	Loop data 2001	Travel time, time of day	22.87	RC (phone survey)	38.27
	Liu et al. (2004)	LM (mixed) (MRS)	Loop data 2001	Travel time, toll, distance	12.81	RC (loop detector)	21.43
	Liu et al. (2007)	LM (mixed) (MRS)	Loop data 2001	Traveler choice, travel time	6.82–27.66	RC (loop detector)	11.41–46.28
	Ghosh (2001)	LM	SP/RP 2001	Distance, toll, travel time	20.27 (varies with type data)	RC (phone survey)	33.92
	Small (2005)	MRS	RP/SP 2005	Travel time, toll	RP: 21.46, SP: 11.92	RC (mail survey)	32.54, 18.07
	Krause (2012)	VOT cap procedure (new method)	GPS longitudinal 2012	Cost of trip, duration, route choice	8.34	RC (GPS tracker)	10.36
	Cirillo and Axhausen (2006)	LM (mixed)	SP 2006	Travel time, travel length, mode of ravel	12.00	RC (survey)	17.63
	Hossan (2016)	Logit model (mixed)	SP 2016	Out of pocket monetary cost, trip length, travel time	10.68	RC (online survey)	13.18
	Miao (2014)	MRS	SP 2013		54.98	OO 29%, CD 71%	69.9

Nation	Reference	Method	Data/Year	Variable	VOT Original Date (USD/hr. unless otherwise stated)	Driver Type (data recollection method)	VOT 2022 (USD/hr.)
	FHWA (2002)		2005	Unexpected delays, shipment	25–200	–	37.91–303.28
	Kawamura (2000)	Logit model	1999	Shipment size, business type	23.4	OO (PF) 56%, CD 44% (in-person survey)	41.6
	Calfee and Winston (1998)	Logit model	SP 1998	Transport time, toll	3.88	RC (mail survey)	7.05
	Tilahum and Levinson (2007)	MRS	SP 2006	Toll, departures, delays	9.54–25.43	RC (mail and phone survey)	14.02–37.37
	Levinson and Sunalkoski (2003)	Tobit model	SP 2003	Truckload, toll	49.42	RC (mail survey)	80.35
	Wang (2014)	LM	GPS 2014	Travel time, toll rates, reliability	Peak: 25.15, Off peak: 19.44	ATD (Database)	31.46, 24.31
	Zamparini and Reggiani (2007)	WR	2007		23.29		33.27
	Sheikh et al. (2014)	MRS	SP 2014	Travel time, toll	36.00	RC (Database)	45.04
	GSRTA (2006)		SP 2006		21	ATD (Database)	30.85
	Wolff (2014)	Analyze driver	2005–2008	Driving speed, gasoline price	11.52	RC (Database)	17.47
	ODOT (2004)	WR	Average wage, Fringe cost 2003		Light truck: 18.92, Heavy truck: 25.49	ATD (Database)	30.45, 41.02
Australia	Li et al. (2010)	Scheduling model	SP/RP 2010	Tolls, delays, travel time	30.04	RC	40.87
	Puckett et al. (2007)	LM	SP 2007		31.87–63.75	CD (in person)	46.16–53.22

Nation	Reference	Method	Data/Year	Variable	VOT Original Date (USD/hr. unless otherwise stated)	Driver Type (data recollection method)	VOT 2022 (USD/hr.)
France	de Jong et al. (2001)	MRS	SP/RP 1999/2000	Transport cost, transport time, probability of delay, frequency of shipment, etc.	Hire and reward: 29.00–60.00 French Francs ($4.92–10.18)	ATD (in-person survey)	6.95–14.38
	Meunier and Quinet (2015)		2010		32.7 Euro ($36.50)	ATD	41.8
Germany	F.B.T.C. (1999)	MRS	SP 1999	Transport cost, transport time	21		36.96
	Ehreke et al. (2015)	MRS	SP 2015	Distance, travel time	8.38 Euro ($10.44)	ATD (in-person survey)	11.99
Japan	KOTI (1999)	WR	Average wage, fringe cost 1996		Small truck: 90 yen/min ($48.60) Large truck: 101 yen/min ($54.60)		48.2–56.47
Spain	Alvarez et al. (2007)	MRS	SP 2007		Passenger vehicle: 31.74 Euro ($35.43) Freight vehicles: 64.10 Euro ($71.54) 14.10 Euro ($15.74)	ATD (in-person survey)	42.16, 95.5, 20.88
	Asensio and Matas (2008)	MRS	SP 2008	Travel time, travel cost	Passenger vehicle: 31.74 Euro ($35.43) Freight vehicles: 64.10 Euro ($71.54) 14.10 Euro ($15.74)	RC (in-person survey)	45.35, 91.74, 20.15
Sweden	Lei (2011)	Logit model	2011	Travel time, distance, toll	Work trips: 176 SEK ($18.54) Other trips: 184 SEK ($19.39)	RC	23.32, 24.39

Nation	Reference	Method	Data/Year	Variable	VOT Original Date (USD/hr. unless otherwise stated)	Driver Type (data recollection method)	VOT 2022 (USD/hr.)
Netherlands	de Jong (2007)	MRS	SP/RP 2010	Transport cost, cargo component	Container 2–40t truck: 59 Euro ($65.85) Non-container: (2–15t truck) 23 Euro ($25.67) (2–40t truck) 44 Euro ($49.11)	ATD	96.53,33.72, 71.7
	Kouwenhoven et al. (2014)	Latent class models	SP 2011	Cost, travel time, travel time variability	Commute: 9.25 Euro ($10.32) Business: 26.25 Euro ($29.30) All purpose: 9.00 Euro ($10.05)	RC	12.83, 36.42, 12.4

The evaluation results from the PI's previous MTI project were reaffirmed with key factors that influence route choice characteristics. In other words, the key factors of the values of time, reliability, and safety are identified as common factors by the review of current studies. The three factors are used when seeking the opinions from both company truck drivers and owner-operator truck drivers in the region of Southern California in this study.

Company truck drivers are assigned a route by the company itself. On the other hand, owner-operator truck drivers make decisions when evaluating the best and most suitable route for a trip since they select their own route, and their value of time is not restricted by hourly wages. Nonetheless, the perspective of company truck drivers with respect to tolerance for time and route choice characteristics demonstrates a comparative reference to understand company truck drivers' and owner-operator truck drivers' different preferences. The most important criterion for route selection is the route's characteristics, besides the alternatives under the route characteristics: namely, travel time and reliability of on-time arrival characteristics. The significance of these factors is expected because the variables of reliability of on-time arrival and travel time are two variables that are frequently recognized in related studies. Safety also plays a significant role within this criterion, which is consistent with expectations.

An additional and relevant factor is cost of travel, as it is directly associated with travel time. It is notable that only a few studies considered the factor of scheduled delivery as an alternative variable, as the factor is substantially high in comparison to all other alternatives. The other alternatives within the criterion are being behind schedule and congestion hotspots, which play a minor role in truck drivers' decision making but are related to whether the driver will be on time for a scheduled delivery. None of these studies focused on both company truck drivers and owner-operator truck drivers in the Southern California freeway systems. Another explanation is that truck operators perceive these recognized variables as important. Moreover, the value of time that the studies extend does not categorize the types of drivers; it includes all types of truck drivers or, at a certain level, all types of drivers on a highway. Further analysis of owner-operator truck drivers and company truck driver is necessary. Type of ownership and hiring classification could present a significant difference on the following factors: value of reliability (VOR), value of time (VOT), and safety. Their opinions might suggest that further data collection is necessary to obtain a more accurate representation of the diverse population of drivers, which is the motivation of this research.

The goal of this research project is to better understand the behaviors of both owner-operator truck drivers and company truck drivers to enhance the decision-making of policymakers and transportation agencies regarding route choice characteristics. The main objectives of this research are to estimate the values that the drivers place on time, reliability, and safety factors of their travel routes and to provide transportation agencies with meaningful data on these drivers' behaviors and patterns. To achieve this, the research team implemented the stated-preference survey method by meeting face-to-face with owner-operator truck drivers and company truck drivers in the field.

The findings will help obtain a better understanding of the contemporary issues and demands that face truck drivers. The research outcome is to produce high-quality field data and discuss the corresponding analytical results on truck travel patterns, which will be of interest to transportation agencies by virtue of being applicable to estimating the utility of a truck-only toll lane.

3. Methodology

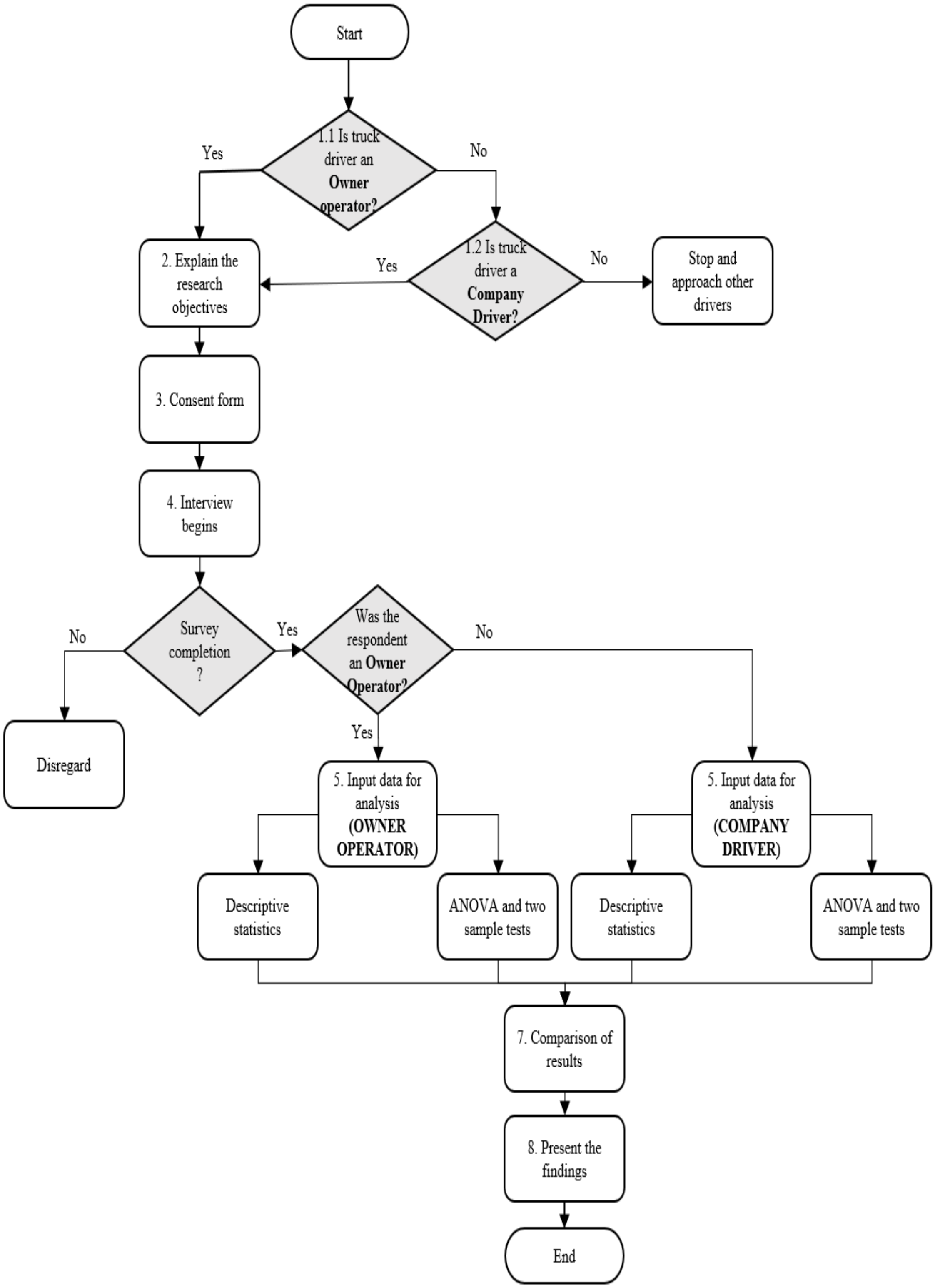
The survey was conducted using the stated-preference survey method with both company and owner-operator truck drivers. The research team met face-to-face with prospective participants who were asked if they agreed to engage in a survey and, if so, to answer the questions on the form. The survey form aims to determine if the truck drivers frequented the Ports of Los Angeles and Long Beach, who owns the truck, the number of axles they drive, and the number of years they have spent driving semi-trucks. The project's boundary conditions delimited the design of scenarios proposed by the research team. The starting point is either the Port of Long Beach (LB) or the Port of Los Angeles (LA), and the end points are designated distribution centers located in different cities across Southern California. A scenario is a specific route considering route characteristics such as the route itself, distance, toll charge, average speed, reliability, time of day, quantity of passenger cars, and weather conditions. The scenarios for the full design were selected from the following list, which encompasses the possible routes; however, not all the routes were selected, as some were not commonly used by truck drivers. The (*) indicates the nine scenarios used in the stated-preference survey form (see also the Appendix).

- Los Angeles Port to Pasadena on I-110 with time factor (*)
- Long Beach Port to Compton on I-710 with time factor
- Long Beach Port to Compton on I-710 with safety and weather factor
- Long Beach Port to Santa Fe Springs on I-710 with different reliability (*)
- Long Beach Port to Santa Fe Springs on I-710 with safety factor (*)
- Long Beach Port to Van Nuys on I-405 with safety factor
- Long Beach Port to Van Nuys on I-405 with time factor (*)
- Long Beach Port to Van Nuys on I-405 with different reliability and toll (*)
- Los Angeles Port to San Diego on I-5 with time factor (*)
- Los Angeles Port to San Diego on I-5 with safety factor (*)
- Los Angeles Port to Pasadena on I-110 different reliability and toll (*)
- Los Angeles Port to Pasadena on I-110 with safety factor (*)

- Long Beach Port to Carson on I-710 with truck gas mileage measure
- Long Beach Port to Lake Forest on I-405 with truck gas mileage measure
- Los Angeles Port to Gardena on I-110 with truck cargo price measure
- Los Angeles Port to Dana Point on I-5 with truck cargo price measure
- Los Angeles Port to Carson on I-110 with truck comfort level measure
- Santa Clarita to San Clemente on I-5 with truck comfort level measure

Nine scenarios were carefully designed to help understand both company truck drivers' and owner-operator truck drivers' perspectives on truck-only toll lanes for Southern California freeways near the Ports of Long Beach and Los Angeles. Thus, every scenario uses one or more key comparison factors such as VOT, VOR, or safety factors. The key comparison factors were chosen prior to conducting interviews because they are the factors that hold the most value for truck drivers based on the literature review as well as the findings of the PI's previous MTI project (Kim et al. 2021). Additionally, each scenario contains a truck-only toll lane option and a no-toll option. The scenarios vary in route, distance, toll charge, average speed, reliability, time of day, quantity of passenger cars, and weather conditions. The survey collects responses from two types of truck drivers: owner-operator truck drivers and company truck drivers. The survey form was approved by California State University, Long Beach's Institutional Research Board (IRB). Figure 1 is a flowchart depicting the research methodology.

Figure 1. Flowchart for Research Methodology



3.1 Scenarios Used in Survey

The possible scenarios were evaluated based on the frequency that truck drivers use those routes and the importance that each route had to the freight system in Southern California. Table 2 presents nine selected scenarios that consider the origin's location, the final destination, the freeways utilized, and the travel distance. The table also presents two different situations: the first is a no-toll lane with values of travel time and average speed for vehicles currently driving in the route, and the second considers trucks driving in a toll lane with their travel time and average speed changed by the implementation of the truck-only lane.

Table 2. Scenarios Used in the Survey

	Route factor (toll charge $)	**Origin**	**Destination**	**Distance [(mi)]**	**Not on toll lane**			**On toll lane**		
					Situation	Travel time (min)	Average speed (mph)	Situation	Travel time (min)	Average speed (mph)
1	VOT (15)	Port of LA (on I-110)	Pasadena	30	Heavy traffic	60	30	Little traffic	30	60
2	VOR (10)	Port of LB (on I-710)	Santa Fe Springs	20	Low reliability	20–60	20–60	High reliability	30	40
3	VOT (30)	Port of LB (on I-405)	Van Nuys	45	Heavy traffic	180	15	Little traffic	45	60
4	VOR (15)	Port of LB (on I-405)	Van Nuys	45	Low reliability	45–180	15–60	High reliability	90	30
5	VOT	Port of LA (on I-5)	San Diego	120	Heavy traffic	360	20	Little traffic	120	60
6	Safety	Port of LA (on I-5)	San Diego	120	Low Safety change of lanes	120	60	High Safety on one lane	120	60
7	VOR	Port of LA (on I-110)	Pasadena	30	Heavy Traffic	40–90	20–45	Little traffic	60	30
8	Safety	Port of LB (on I-710)	Santa Fe Springs	32.19 (20)	Low Safety with heavy rain	40	30	High Safety with no rain	20	60
9	Safety	Port of LA (on I-110)	Pasadena	48.28 (30)	Low Safety, night-time	35	50	High Safety, daytime	35	50

Scenario 1

Scenario 1 presents a 30-mile route from the Port of LA to Pasadena on the I-110, originally on a no-toll lane, with an average speed of 30 mph, a travel time of 60 minutes, and heavy traffic. For the same route, Scenario 1 describes a $15 truck-only toll lane with little traffic and a travel time of 30 minutes, increasing the average speed to 60 mph, and using VOT as a key comparison factor.

Scenario 2

Scenario 2 presents a 20-mile route from the Port of LB to Santa Fe Springs on the I-710, originally on a no-toll lane, with an average speed between 20 and 60 mph, a travel time between 20 and 60 minutes, and low reliability. For the same route, Scenario 2 describes a $10 truck-only toll lane with high reliability and a travel time of 30 minutes, changing the average speed to 40 mph, and using VOR as a key comparison factor.

Scenario 3

Scenario 3 presents a 45-mile route from the Port of LB to Van Nuys on the I-405, originally on a no-toll lane, with an average speed of 15 mph, a travel time of 180 minutes, and heavy traffic. For the same route, Scenario 3 describes a $30 truck-only toll lane with little traffic and a travel time of 45 minutes, changing the average speed to 60 mph, and using VOT as a key comparison factor.

Scenario 4

Scenario 4 presents a 45-mile route from the Port of LB to Van Nuys on the I-405, originally on a no-toll lane, with an average speed between 15 and 60 mph, a 50% chance of a 45-minute travel time, a 50% chance of a 180-minute travel time, and low reliability. For the same route, Scenario 4 describes a $15 truck-only toll lane with high reliability and a travel time of 90 minutes, changing the average speed to 30 mph, and using VOR as a key comparison factor.

Scenario 5

Scenario 5 presents a 120-mile route from Los Angeles to San Diego on the I-5, originally on a no-toll lane, with an average speed of 20 mph, a 360-minute travel time, and heavy traffic. For the same route, Scenario 5 describes a $60 truck-only toll lane with low traffic and a travel time of 120 minutes, changing the average speed to 60 mph, and using VOT as a key comparison factor.

Scenario 6

Scenario 6 presents a 120-mile route from Los Angeles to San Diego on the I-5, originally on a no-toll lane, with an average speed of 60 mph, a 120-minute travel time, and low safety with constant lane changes. For the same route, Scenario 6 describes a $5 truck-only toll lane with high safety and no changes of lanes, a travel time of 120 minutes, an average speed of 60 mph, and using safety as a key comparison factor.

Scenario 7

Scenario 7 presents a 30-mile route from the Port of LA to Pasadena on the I-110, originally on a no-toll lane, with an average speed between 20 and 45 mph, a 50% chance of a 40-minute travel time, a 50% chance of a 90-minute travel time, and low reliability. For the same route, Scenario 7 describes a $15 truck-only toll lane with high reliability and a travel time of 60 minutes, changing the average speed to 30 mph, and using VOR as a key comparison factor.

Scenario 8

Scenario 8 presents a 20-mile route from Long Beach to Santa Fe Springs on the I-710, originally on a no-toll lane, with an average speed of 30 mph, a 40-minute travel time, and low safety with heavy rain. For the same route, Scenario 8 describes a $5 truck-only toll lane with high safety and no rain, in a travel time of 20 minutes, an average speed of 60 mph, and using safety as a key comparison factor.

Scenario 9

Scenario 9 presents a 30-mile route from Los Angeles to Pasadena on the I-110, originally on a no-toll lane, with an average speed of 50 mph, a 35-minute travel time, and low safety at night. For the same route, Scenario 9 describes a $5 truck-only toll lane with high safety at daytime, a travel time of 35 minutes, average speed of 50 mph, and using safety as a key comparison factor.

4. The Data Collection Process

4.1 Scope of the Study

The research team selected the research boundary within Southern California's network of toll-free and toll roads. The toll roads include those operated and owned by Metro on the I-110 and I-10, those operated and owned by the Orange County Transportation Authority on 91 express lanes, other toll roads operated by Transportation Corridor Agencies on the 241, the 261, the 133, and the 73, and those operated by San Diego County on the I-15 express lanes and SR-125 (Southern California Toll Roads 2014). Per FHWA (2021), the 2010 information is based on the count of 44,000 vehicles/day, with 3.1% of those vehicles being trucks (1,368 trucks/day), and over two-thirds of these trucks having two or three axles. When analyzing other locations further, the percentages are presented at the start of the I-710 in the Port of LB (26.4%), I-405 north (14.3%), I-5 north (7.6%), and between the I-10 and SR 60 (5.0%). Data from truck count does not provide any information regarding the focus of this research, which are the origins and destinations of trucks, as it only provides useful information regarding the transit of trucks on certain routes.

The National Highway Freight Network, according to the FHWA (2021), encompasses 6,804.66 miles of corridors to transport freight in the state of California and is divided in four categories: critical rural freight corridors, critical urban freight corridors, the California non-PHFS interstate highway, and the primary highway freight system (PHFS). The two main connections to the intermodal freight system around the Ports of LB and LA are the I-110 and I-710. Both freeways later connect with the I-405 and the I-5 along their way toward the northwest part of Southern California. The four mentioned freeways—the I-110, I-710, I-405, and I-5—consist in the principal links of the freight system coming from the Port of LB to the Los Angeles area.

A significant amount of the origin and destination of goods transportations does not include the Port of San Pedro. More than 85% of truck trips in Los Angeles County stay inside the Southern California Association of Governments (SCAG) six-county region without considering the San Pedro ports. For instance, some of these trucks transport goods to regional distribution centers to local businesses or manufacturers. Around 6% of trucks travel outside the region to transport agricultural products from the Central Valley to the southwest of the United States. Less than 8% of truck trips start in the Los Angeles County region, end at the San Pedro ports, or are moving goods from the ports.

4.2 Data Collection Process

The development of the data collection process involved the following design stages: the establishment of locations to conduct the surveys, the recruitment of participants, and the survey collection process. The focus on this research requires a location where the research team could encounter both owner-operator truck drivers and company truck drivers in the area to collect their responses. Hence, the selection of the survey location was an essential stage in the collection of data because it had to meet a number of survey requirements, and it had to be carried out in an area that both types of drivers frequent. Figure 2 shows a map of the survey's locations of interest.

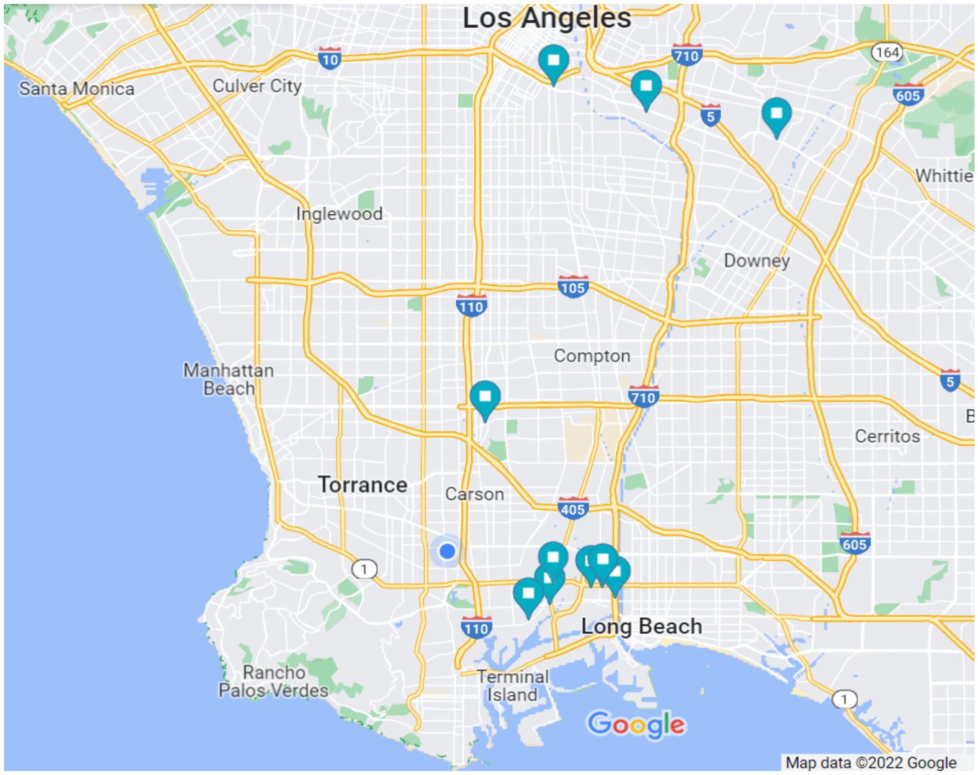
Criteria for the survey location selection was devised in order to accommodate the lifestyle of working company truck drivers and owner-operator truck drivers. This criteria required that the location satisfied the following conditions:

(1) First, the location needed to be close to the Ports of LB and LA, surrounded by large area and facilities that could receive a considerable amount of truck drivers. The respondents who were willing to participate have to be familiar with the routes mentioned in the survey.

(2) Second, the location needed to be a place or area where the survey activity would be appropriate in terms of safety, accessibility, and noise level such that participants and researchers could interact and speak comfortably with each other. The location also needed to be a place where participants had the time to complete the survey process without constant interruptions from their surroundings. An example of an inappropriate survey location is the side of a busy street because such locations can be loud and unsafe, and the respondents and the research team would be focused on their safety rather than conducting the survey efficiently. An example of an appropriate survey location is a safe street that is not busy, with parking availability for several trucks, and rest stops or refreshment areas nearby to assure that drivers are not working.

(3) Third, the location needed to be a resting stop or a place where truck drivers were not busy on their work routines, due to the fact that the survey could be perceived as a distraction to their activities.

Figure 2. Map of Survey Locations of Interest



In addition to the location selection, the process of finding willing participants, or the "participant requirement," is also a critical stage in the data collection process that is largely dependent on the quality of the selected survey location. Provided that the selected area was suitable, the process of recruiting participants involved approaching drivers, introducing the research team and the purpose of the research, explaining how long the survey would take, and asking whether they would be willing to participate in a face-to-face survey. The authors conducted the interviews every morning in the locations selected in order to avoid any bias associated with the time and location of survey solicitations.

The research team later asked whether the drivers owned their truck or if it was company-owned, which helped to identify the type of driver. The survey was conducted in English, however when the respondent preferred to speak in Spanish, the research team asked the questions in Spanish. Additionally, two methods were offered to respond: the use of an electronical tablet with a digital survey format or a paper alternative. If owner-operator truck drivers and company truck drivers agreed to participate in the survey, the researcher would explain the consent form and remind them that their responses would remain confidential and that the survey would not focus on personal questions, but on professional experiences and opinions. To assure participants of the survey's confidentiality, no audio was recorded. On average, the survey lasted around ten to twenty minutes. Many owner-operator truck drivers and company truck drivers used the survey as a platform to discuss the lifestyle of being an owner-operator truck driver or a company truck driver, as well as the economic impact of increasing regulations and fees, the current state of the freight industry, and the state of the transportation system in the region. Finally, after the questions relating to the nine scenarios were completed, an additional survey section was reserved for the truck drivers to write their opinions regarding the implementation of truck-only lanes in Southern California and their perception towards toll fees. Drivers answered the questions, but also took the opportunity to convey additional comments and inconveniences that they had while driving in the area, which, on occasion, made the interview extend past twenty minutes.

4.3 Data Collected

The research team collected stated-preference survey data by meeting face-to-face with the owner-operator truck drivers and company truck drivers. The total number of individuals who attempted the survey was 62. Of those, some truck drivers did not actually participate in the survey due to one or more of the following reasons: (1) they were waiting on a client to call them for work, (2) they did not have time to do a survey, (3) they believed that the research advocates for increased tolls, and (4) they believed that their voice would not be heard or that the research would have no impact. Also, some drivers began the survey but did not complete it due to one or more of the aforementioned reasons. Incomplete survey data was eliminated from the data analysis. Of those whom the facilitators met, 45 truck drivers of combined data from owner-operators and company truck drivers completed the survey, with a 72.58% of acceptance towards the survey by respondents. Besides the drivers that responded in English, a considerable number of drivers increased their willingness to respond when Spanish was presented as an alternative language. Out of the 45 respondents, 20 individuals were owner-operators (44.44%) and 25 (55.56 %) were company truck drivers, and their responses were used for data analysis in three different categories: (1) combined data from both drivers; (2) data from owner-operator truck drivers; and (3) data from company truck drivers. Collectively, the truck drivers possess an average experience of 10.64 years with a median of 13 years. Owner-operators average 12.75 years of experience with a median of 13 years, and company truck drivers average 8.96 years of experience with a median of 8 years.

5. Results

The stated-preference survey data obtained from the owner-operator truck drivers and company truck drivers are presented having undergone statistical analysis. First, the tolerated toll fees that owner-operator truck drivers and company truck drivers are willing to pay when taking a truck-only toll lane are compared in each of the above-listed scenarios that reflect different route characteristics. This comparison is presented with descriptive statistics results. Second, a one-way analysis of variance (ANOVA) was conducted to compare the nine scenarios using combined data of both types of drivers. Third, the overall preference for truck-only toll lanes in scenarios having the same origin and destination are compared to the perspectives of combined data from owner-operator truck drivers and company truck drivers when considering route choices. Fourth, a comparison of the tolerated fees between owner-operators and company truck drivers determines the difference in value that each type of driver assigns to a similar scenario. Fifth, the comparisons of VOT, VOR, and safety factors are made in terms of the tolerated toll fee amounts in the metrics of $ an hour and $ per mile among the groups of scenarios that have these factors.

5.1 Descriptive Statistics for Tolerated Toll Fees

Table 3 shows the descriptive statistics for the tolerated toll fees by scenario from the combined data for owner-operator truck drivers and company truck drivers. The tolerated toll fees range from $3.27 an hour to $41.45 an hour during weekdays, while those fees range from $3.04 an hour to $36.12 an hour during weekends. The tolerated average toll fees are $20.50 an hour and $18.12 an hour for weekdays and weekends, respectively. Figure 3 shows the comparison of tolerated toll fees by scenario in $ an hour and in $ per mile metrics.

Moreover, Table 4 presents the descriptive statistics for the tolerated toll fees by scenario from data for only owner-operator truck drivers. The tolerated fees range from $3.40 an hour to $37.93 an hour during weekdays, while those fees range from $3.20 an hour to $32.6 an hour during weekends. The tolerated average toll fees are $19.18 an hour and $16.31 an hour for weekdays and weekends, respectively. Figure 4 shows the comparison of tolerated toll fees by scenario in $ an hour and in $ per mile metrics.

Table 5 presents the descriptive statistics for the tolerated toll fee by scenario from data for only company truck drivers. The tolerated fees range from $3.16 an hour to $44.27 an hour during weekdays, while those fees range from $2.92 an hour to $38.93 an hour during weekends. The tolerated average toll fees are $21.56 an hour and $19.58 an hour for weekdays and weekends, respectively. Figure 5 shows the comparison of tolerated toll fees by scenario in $ an hour and in $ per mile metrics.

Table 3. Descriptive Statistics for Tolerated Toll Fees by Scenario
(Combined Data from Owner-Operator Truck Drivers and Company Truck Drivers)

Scenario		N	Mean total toll ($)	Mean ($/mile)	Mean ($/hr.)	Mode	Median	Std. Dev	SE Mean	Min.	Max.
1	Weekdays	45	16.69	0.56	33.38	15.00	15.00	6.79	1.01	5.00	30.00
	Weekend	45	14.58	0.49	29.16	15.00	15.00	7.49	1.12	5.00	30.00
2	Weekdays	45	10.56	0.53	21.11	10.00	10.00	4.53	0.68	4.00	20.00
	Weekend	45	9.58	0.48	19.16	8.00	8.00	4.41	0.66	2.00	20.00
3	Weekdays	45	31.09	0.69	41.45	30.00	30.00	10.84	1.62	9.00	60.00
	Weekend	45	27.09	0.60	36.12	30.00	30.00	11.89	1.77	9.00	60.00
4	Weekdays	45	17.09	0.38	11.39	15.00	15.00	6.57	0.98	5.00	40.00
	Weekend	45	15.09	0.34	10.06	15.00	15.00	7.13	1.06	5.00	40.00
5	Weekdays	45	57.53	0.48	28.77	60.00	60.00	20.92	3.12	15.00	120.0
	Weekend	45	50.87	0.42	25.43	45.00	45.00	21.69	3.23	15.00	120.0
6	Weekdays	45	6.53	0.05	3.27	6.00	6.00	3.49	0.52	0.00	24.00
	Weekend	45	6.09	0.05	3.04	4.00	6.00	3.72	0.55	0.00	24.00
7	Weekdays	45	17.47	0.58	17.47	15.00	15.00	7.61	1.13	5.00	40.00
	Weekend	45	15.36	0.51	15.36	15.00	15.00	7.23	1.08	5.00	40.00
8	Weekdays	45	5.78	0.29	17.33	6.00	6.00	2.03	0.30	2.00	10.00
	Weekend	45	5.20	0.26	15.60	4.00	4.00	2.17	0.32	2.00	10.00
9	Weekdays	45	6.04	0.20	10.36	6.00	6.00	1.86	0.28	2.00	10.00
	Weekend	45	5.38	0.18	9.22	6.00	6.00	2.10	0.31	2.00	10.00

Figure 3. Comparison of Tolerated Toll Fees by Scenario
(Combined Data from Owner-Operator Truck Drivers and Company Truck Drivers)

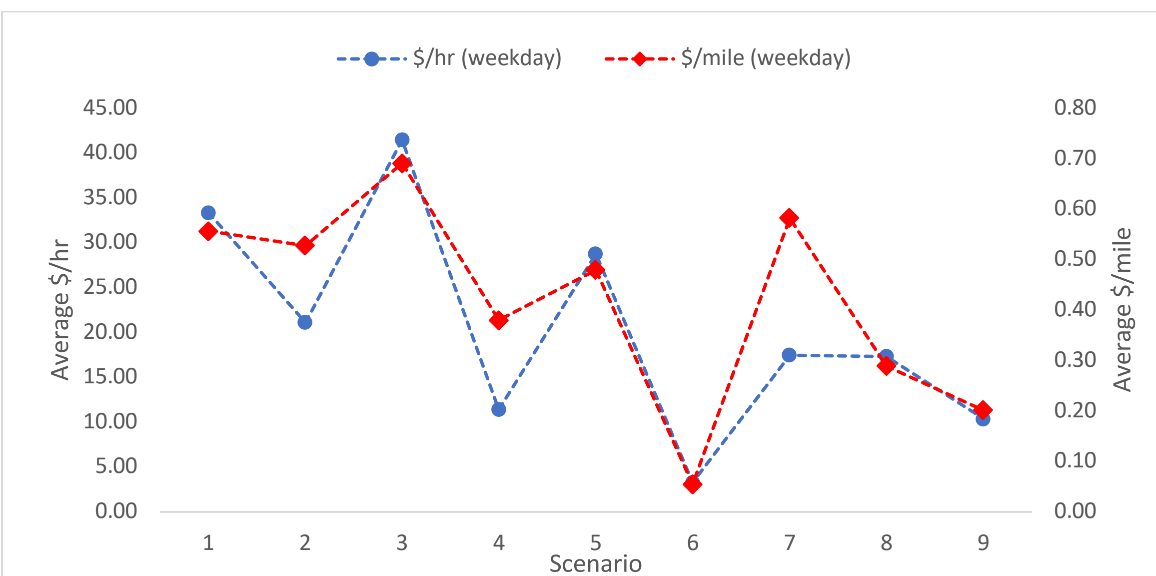


Table 4. Descriptive Statistics for Tolerated Toll Fees by Scenario
(Owner-Operator Truck Drivers)

Scenario		N	Mean total toll ($)	Mean ($/mile)	Mean ($/hr.)	Mode	Median	Std. Dev	SE Mean	Min.	Max.
1	Weekdays	45	15.55	0.52	31.10	15.00	15.00	7.16	1.07	5.00	30.00
	Weekend	45	13.05	0.44	26.10	10.00	10.00	6.73	1.00	5.00	30.00
2	Weekdays	45	9.65	0.48	19.30	10.00	10.00	4.59	0.68	4.00	20.00
	Weekend	45	8.10	0.41	16.20	8.00	8.00	3.58	0.53	2.00	20.00
3	Weekdays	45	28.45	0.63	37.93	30.00	30.00	9.73	1.45	9.00	40.00
	Weekend	45	24.45	0.54	32.60	30.00	30.00	10.31	1.54	9.00	40.00
4	Weekdays	45	15.45	0.34	10.30	15.00	15.00	6.35	0.95	5.00	30.00
	Weekend	45	13.20	0.29	8.80	15.00	12.50	6.41	0.96	5.00	30.00
5	Weekdays	45	53.70	0.45	26.85	60.00	60.00	21.27	3.17	15.00	90.00
	Weekend	45	44.70	0.37	22.35	60.00	45.00	19.25	2.87	15.00	90.00
6	Weekdays	45	6.80	0.06	3.40	6.00	6.00	4.66	0.70	0.00	24.00
	Weekend	45	6.40	0.05	3.20	6.00	6.00	4.88	0.73	0.00	24.00
7	Weekdays	45	16.80	0.56	16.80	15.00	15.00	8.63	1.29	5.00	30.00
	Weekend	45	14.05	0.47	14.05	10.00	12.50	6.94	1.03	5.00	30.00
8	Weekdays	45	5.50	0.28	16.50	4.00	6.00	2.09	0.31	2.00	10.00
	Weekend	45	4.80	0.24	14.40	4.00	4.00	2.14	0.32	2.00	10.00
9	Weekdays	45	6.10	0.20	10.46	6.00	6.00	1.84	0.27	2.00	10.00
	Weekend	45	5.30	0.18	9.09	6.00	6.00	2.03	0.30	2.00	10.00

Figure 4. Comparison of Tolerated Toll Fees by Scenario
(Owner-Operator Truck Drivers).

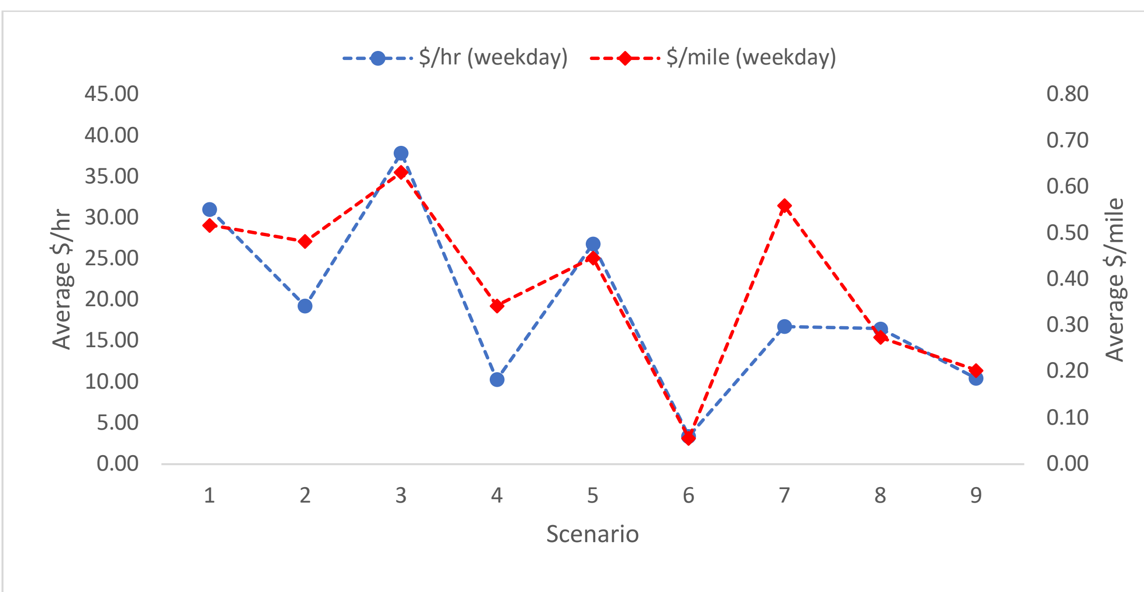
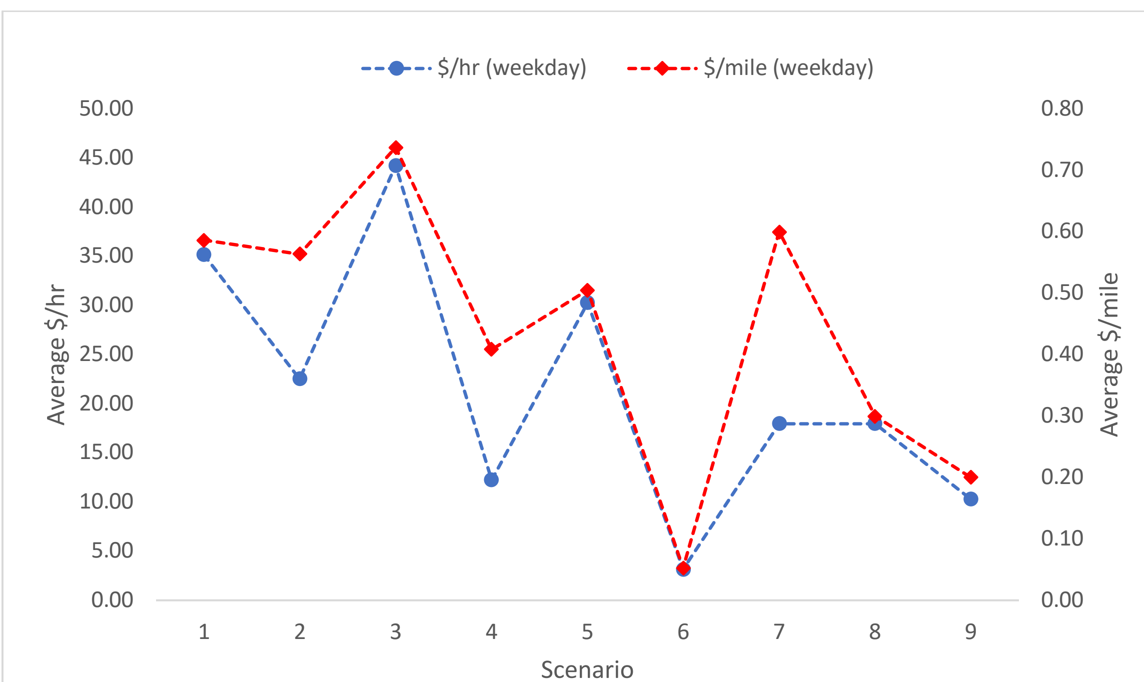


Table 5. Descriptive statistics for tolerated toll fees by scenario (Company truck drivers)

Scenario		N	Mean total toll ($)	Mean ($/mile)	Mean ($/hr.)	Mode	Median	Std. Dev	SE Mean	Min.	Max.
1	Weekdays	45	17.6	0.59	35.20	15	15	6.34	0.95	10	30
	Weekend	45	15.8	0.53	31.60	15	15	7.83	1.17	5	30
2	Weekdays	45	11.28	0.56	22.56	10	10	4.36	0.65	5	20
	Weekend	45	10.76	0.54	21.52	10	10	4.66	0.69	5	20
3	Weekdays	45	33.2	0.74	44.27	30	30	11.21	1.67	20	60
	Weekend	45	29.2	0.65	38.93	20	30	12.62	1.88	10	60
4	Weekdays	45	18.4	0.41	12.27	15	15	6.44	0.96	10	40
	Weekend	45	16.6	0.37	11.07	15	15	7.31	1.09	5	40
5	Weekdays	45	60.6	0.51	30.30	60	60	20.12	3.00	45	120
	Weekend	45	55.8	0.47	27.90	45	45	22.26	3.32	30	120
6	Weekdays	45	6.32	0.05	3.16	6	6	2.09	0.31	4	10
	Weekend	45	5.84	0.05	2.92	4	6	2.39	0.36	2	10
7	Weekdays	45	18	0.60	18.00	15	15	6.63	0.99	10	40
	Weekend	45	16.4	0.55	16.40	15	15	7.28	1.09	5	40
8	Weekdays	45	6	0.30	18.00	6	6	1.96	0.29	2	10
	Weekend	45	5.52	0.28	16.56	4	4	2.14	0.32	2	10
9	Weekdays	45	6	0.20	10.29	6	6	1.88	0.28	2	10
	Weekend	45	5.44	0.18	9.33	4	6	2.16	0.32	2	10

Figure 5. Comparison of Tolerated Toll Fees by Scenario (Company Truck Drivers)



5.2 Comparison of Mean Tolerated Toll Fees among Nine Scenarios

A one-way analysis of variance (ANOVA) is conducted to compare the mean tolerated toll fees of nine different scenarios. The purpose of the one-way ANOVA is to compare the mean tolerated toll fees among nine scenarios to determine the difference in the extent to which both owner-operator truck drivers and company truck drivers are willing to pay for truck-only toll lanes when choosing their routes.

The ANOVA tests the null hypothesis that nine scenarios are drawn from populations with the same mean values. The research team assumed that owner-operator truck drivers' and company truck drivers' response variable residuals are normally distributed or approximately normally distributed, the responses are independent, the variances of populations are equal, and the responses for the scenarios are independent and identically distributed normal random variables. Minitab 22, which is the latest versions of one of Minitab's software packages, is used for statistical analysis. The one-way ANOVA is used to test whether there is variation in the preferences for the mean tolerated toll fees across the route choices presented in the various scenarios. The null and alternative hypotheses are H_o: $\mu_{Si} = 0$ for all i, where i is the i^{th} scenario, and H_a: *at least two mean toll fees among nine scenarios differ*. At a 0.05 level of significance, the null hypotheses are rejected if the p-value is smaller than 0.05. Then, the authors can obtain sufficient evidence to show that the null hypothesis is not true.

Table 6 tabulates the one-way ANOVA results for the tolerated toll fees from the combined data from owner-operator truck drivers and company truck drivers who are willing to pay when they choose routes given the different trip origin, trip destination, highway of choice, toll charges, travel time, average speed, reliability, and safety. Based on the survey data, the test statistic, $F = 124.34$, has a p-value of 0.000. F-value is a test statistic obtained from the data and is used to compare against the critical F-value from the F table. The p-value is the probability of obtaining a test statistic as large as the F value, assuming H_o is true. Since the p-value is less than $\alpha = 0.05$, the null hypothesis can be rejected. Therefore, it can be concluded that there is a statistically significant difference among the nine scenarios, and that depending on the route choice characteristics, truck drivers tolerate different toll fee values. Additionally, one-way ANOVA was conducted for the results of owner-operator truck drivers and company truck drivers separately, as is tabulated on Tables 7 and 8, respectively. The results provide a p-value less than $\alpha = 0.05$ in both types of truck drivers. Consequently, it can be concluded that there is a statistically significant difference among the nine scenarios, notwithstanding the driver owning a truck or working for a company. Tukey's confidence intervals were created for all pairwise differences to compare the tolerated mean toll fees while controlling the family error rate at a 95% level. The Tukey 95% simultaneous confidence intervals for all pairwise comparisons among the nine scenarios show that half of the pairwise comparisons for the null hypothesis are rejected while the rest are not rejected. The results suggest that further analysis is needed to examine to what degree route choice factors such as VOT, VOR, and safety affect the willingness of owner-operator truck drivers' and company truck drivers' tolerated toll fees.

Table 6. ANOVA Results on Tolerated Toll Fees for All Nine Scenarios
(Combined Data from Owner-Operator Truck Drivers and Company Truck Drivers)

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Factor	8	170.18	21.2720	124.34	0.000
Error	396	67.75	0.1711147.3		
Total	404	237.92			

Table 7. ANOVA Results on Tolerated Toll Fees for All Nine Scenarios
(Owner-Operator Truck Drivers)

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Factor	8	48.01	6.0013	38.73	0.000
Error	171	26.49	0.1549		
Total	179	74.5			

Table 8. ANOVA Results on Tolerated Toll Fees for All Nine Scenarios
(Company Truck Drivers)

Source	DF	Adj. SS	Adj. MS	F-Value	P-Value
Factor	8	74.36	9.29525	103.44	0.000
Error	216	19.41	0.08986		
Total	224	93.77			

5.3 Comparison of Mean Tolerated Toll Fees of Scenarios with Same Origins and Destinations

The research team conducted an experiment to compare the overall preference of truck-only toll lanes for the combined data of owner-operator truck drivers and company truck drivers to choose routes for the same origin and destination scenarios. The research hypothesis is to examine whether there is a significant difference in their preferences between two scenarios. The difference is a metric to show whether both groups of truck drivers prefer truck-only toll lanes. In most cases, the actual variance or standard deviation of either of the two population groups is unknown.

It is assumed that route choice preference samples are randomly and independently drawn from truck drivers that are normally distributed and that the population variances are equal. Thus, the experimental method using two sample *t*-tests, assuming equal variance, is appropriate because it determines whether a significant difference exists between the means of the two populations (Kim et al. 2021). A two-sample *t*-test is a method to statistically determine whether the population means of two independent groups differ (Minitab 2021). Thus, the authors conducted two-sample *t*-tests for hypothesis testing. The hypothesis being tested is whether the overall preferences indicate a willingness to pay toll fees on truck-only toll lanes (μ_1) that exceeds those not willing to pay toll fees (μ_2). The mathematical form of the hypothesis is that H_o: $\mu_1 - \mu_2 = 0$ and H_a: $\mu_1 - \mu_2 > 0$. Table 9 shows the statistical results for the scenarios that have the same origins and destinations.

Table 9. Statistical Results for Same Origin and Destination

Comparison	(factors)	Destination	Diff.	Pooled Std. Dev.	95% CI for Difference	*T*-value	*P*-value
1 vs. 7	(VOT vs Safety)	Pasadena	0.725	0.493	(0.518; 0.931)	6.98	0.000
2 vs. 8	(VOR vs Safety)	Santa Fe S.	0.1877	0.414	(0.0141; 0.3613)	2.15	0.034
3 vs. 4	(VOT vs VOR)	Van Nuys	1.4014	0.431	(1.2202; 1.5826)	15.41	0.000
1 vs. 9	(VOT vs Safety)	Pasadena	1.1714	0.427	(0.9915; 1.3512)	13.01	0.000
7 vs. 9	(VOR vs Safety)	Pasadena	0.4466	0.367	(0.2924; 0.6007)	5.77	0.000
5 vs. 6	(VOT vs VOR)	San Diego	1.7988	0.364	(1.6457; 1.9520)	23.44	0.000

Six comparisons are made between two scenarios having the same origin and destination but different route choice characteristics. At a 0.05 level of significance, the null hypotheses are rejected for the comparisons of scenarios 1 vs. 7, 2 vs. 8, 3 vs. 4, 1 vs. 9, 7 vs. 9, and 5 vs. 6, respectively, because the *p*-value is smaller than 0.05. There is sufficient evidence to show that the null hypothesis is not true.

Scenarios 1 and 7 have the same route from the Port of LA on the I-110 to Pasadena, but their characteristics are different in that Scenario 1 focuses on the VOT factor while Scenario 7 is based on the safety factor. Scenarios 2 and 8 have the same route from the Port of LB on the I-710 to Compton, but their characteristics differ in that Scenario 2 focuses on VOR and Scenario 8 focuses on safety. In another comparison, Scenarios 3 and 4 present the same route from the Port of LB on the I-405 to Van Nuys, however the characteristics of Scenarios 3 and 4 correspond to VOT and VOR factors, respectively. Moreover, Scenarios 1 and 9 present the same route on the I-110 to Pasadena, however the characteristics of Scenario 1 focus on VOT, and Scenario 9 focuses on safety. Scenarios 7 and 9 follow the route on the I-110 to Pasadena, Scenario 7 presents characteristics of VOR, and Scenario 9 of safety. Finally, Scenarios 5 and 6 have the same route from the Port of LA on the I-5 to San Diego; however, the characteristics of Scenarios 5 and 6 correspond to VOT and VOR, respectively.

Both owner-operator truck drivers and company truck drivers showed a different preference to take truck-only toll lanes when choosing a route with two different considered key factors. The null hypothesis is rejected, which means that the mean monetary value that truck drivers are willing to pay for a route with a truck-only lane depends not only on the location (highway or road) that is implemented but also on the key factor that the truck-only lane provides. This leads to the conclusion that truck-only lanes must present a tangible benefit to its future users that justifies the value assigned to the toll-fee. The willingness of truck drivers to pay for a certain toll-fee will vary depending on whether the truck-only lane saves travel time, assures reliability, or enhances safety for drivers.

5.4 Comparison of Mean Tolerated Toll Fees of Company Truck Drivers and Owner-Operator Truck Drivers within Same Scenarios

The research team also conducted an experiment to determine the overall preference of truck-only toll lanes between owner-operator truck drivers and company truck drivers. By comparing the mean tolerated toll fees from owner-operator truck drivers and company truck drivers for the same scenarios with similar route choice characteristics, the research team determined the difference in the extent to which the two types of drivers are willing to pay from their own perspectives. The research hypothesis is to examine whether there is a significant difference in their preferences in one scenario between two types of drivers. In most cases, the actual variance or standard deviation of either of the two population groups is unknown. It is assumed that route choice preference samples are randomly and independently drawn from respective owner-operator truck drivers and company truck drivers that are normally distributed and that the population variances are equal. Thus, the experimental method using two sample *t*-tests, assuming equal variance, is appropriate because it determines whether a significant difference exists between the means of the two populations. The research team conducted two-sample *t*-tests for hypothesis testing using Minitab 22. The hypothesis to test is whether the overall preferences indicate a willingness of owner-operators to pay toll fees on truck-only toll lanes (μ_1) exceeding those of company truck drivers willing to pay toll fees (μ_2). The mathematical form of the hypothesis is that H_o: $\mu_1 — \mu_2 = 0$ and H_a: $\mu_1 — \mu_2 > 0$. Table 10 shows the statistical results for the scenarios with the same origins and destinations.

Table 10. Statistical Results for Same Scenario
(Owner-Operator Truck Drivers vs. Company Truck Drivers)

Scenario (owner-operator truck drivers vs company driver)	Diff.	95% CI for Difference	*T*-value	*P*-value
1 own. vs. 1 comp.	-0.216	(-0.508; 0.075)	-1.51	0.141
2 own. vs. 2 comp.	-0.167	(-0.419; 0.084)	-1.35	0.186
3 own vs. 3 comp.	-0.234	(-0.506; 0.039)	-1.74	0.091
4 own vs. 4 comp.	-0.1784	(-0.3585; 0.0017)	-2.01	0.052
5 own vs. 5 comp.	-0.191	(-0.442; 0.059)	-1.55	0.129
6 own vs. 6 comp.	-0.0141	(-0.1591; 0.1309)	-0.20	0.844
7 own vs. 7 comp.	-0.138	(-0.338; 0.112)	-1.12	0.269
8 own vs. 8 comp.	-0.1203	(-0.3147; 0.0740)	-1.26	0.217
9 own vs. 9 comp.	-0.0187	(-0.1610; 0.1236)	-0.27	0.791

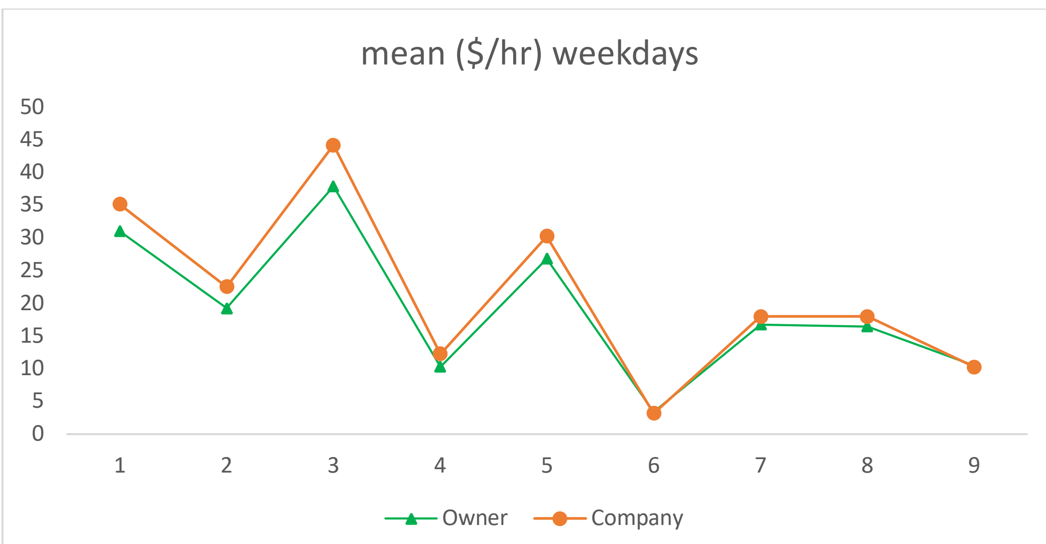
Nine comparisons are made between two types of drivers having the same scenarios as a point of reference. The null hypotheses are not rejected for all nine comparisons of the two types of drivers having the same scenario with similar route choice characteristics. The mean tolerated toll fees of owner-operator truck drivers and company truck drivers were compared. The *p*-values in the comparisons are larger than 0.05, which means that both groups (owner-operator truck drivers and company truck drivers) do *not* show a difference in their tolerance to pay toll fees when evaluating a specific route in the same scenario. This leads to the conclusion that a route with a truck-only toll lane is valued similarly by truck drivers, notwithstanding if they own the truck or if they work for a trucking company. Therefore, when evaluating different routes with key factors such as safety, value of time, and value of reliability, both owner-operator truck drivers and company truck drivers show a similar preference towards the truck-only lane.

After the corresponding two sample *t*-tests, Table 11 shows the descriptive statistic corresponding to mean tolerated toll fees in $ an hour, presented as a comparison between the preference between owner-operator truck drivers versus company truck drivers. Scenarios 1, 2, 3, 4, 5, 7, and 8 show that company truck drivers assign a higher value to toll fees than owner-operator truck drivers. Moreover, Scenarios 6 and 9, both measuring safety as a factor, show a higher value of toll fees from owner-operators than company truck drivers. Figure 6 represents the comparison of both types of drivers in each of the nine scenarios.

Table 11. Comparison of Tolerated Fees Between Owner-Operator Truck Drivers and Company Truck Drivers

Scenario	Owner-operator Mean ($/hr.)	Company Mean ($/hr.)	Difference
1	31.100	35.200	-4.100
2	19.300	22.560	-3.260
3	37.933	44.267	-6.333
4	10.300	12.267	-1.967
5	26.850	30.300	-3.450
6	3.400	3.160	**0.240**
7	16.800	18.000	-1.200
8	16.500	18.000	-1.500
9	10.457	10.286	**0.172**

Figure 6. Comparison of Mean Tolerated Toll Fees Between Owner-Operator Truck Drivers and Company Truck Drivers in the Same Scenario



5.5 Results: Value of Time Factor

Scenarios 1, 3, and 5 vary in route characteristics such as trip origin, trip destination, highway of choice, toll charges, travel time, average speed, reliability, and safety. However, the key factor to be considered is value of time. For each given scenario, owner-operator truck drivers and company truck drivers state whether they prefer to take truck-only toll lanes and record the most amount of money they are willing to pay. Table 12 shows the grouping of three scenarios to demonstrate the variance in the VOT factor.

Table 12. Stated-preference Scenarios for VOT Factor

Scenario No. (Route key factor)	Scenario 1 (VOT)	Scenario 3 (VOT)	Scenario 5 (VOT)
Origin	Port of LA on I-110	Long Beach on I-405	Los Angeles on I-5
Destination	Pasadena	Van Nuys	San Diego
Distance (miles)	30	45	120
Average Speed (mph)	60	60	60
Travel Time (minutes)	30	45	120
Toll Charges (USD)	15	30	60

Table 13 tabulates the tolerated toll fee results for the VOT factor in terms of $ per mile and $ an hour metrics. It is found that the average value of $ per mile during the weekdays (0.576) accounts for a 14.21% increase over the average value for scenarios 1, 3, and 5 during the weekend (0.504). Also, it is found that the average value of $ an hour during weekdays (34.532) accounts for a 14.21% increase over the average value for scenarios 1, 3, and 5 during the weekend (30.236). Additionally, the highest toll fee per mile on any day that drivers are willing to pay when the main factor being compared is the VOT is $0.54 per mile. In other words, the highest toll fee per hour on any day that drivers are willing to pay when the main factor being compared is the VOT is $32.38 an hour.

Table 13. Results on Estimation for VOT Factor

Scenario No.	$/Mile (Weekday)	$/Mile (Weekend)	$/hr. (Weekday)	$/hr. (Weekend)
1	0.56	0.49	33.38	29.16
3	0.69	0.60	41.45	36.12
5	0.48	0.42	28.77	25.43
Column Average	0.576	0.504	34.532	30.236
Weekday/Weekend Average	0.54		32.38	

5.6 Results: Value of Reliability Factor

The key factor to be considered for Scenarios 2, 4, and 7 is the value of reliability. The survey describes reliability as a key factor with these scenarios by comparing the likelihood of short and long travel times. For instance, Scenario 2 describes a 20-mile trip from the Port of LB to Santa Fe Springs using the I-710, where the lack of a toll lane ensures a 50% chance of a 15-minute total travel time and a 50% chance of a 60-minute total travel. However, the use of a toll lane ensures a 100% chance of a 30-minute total travel time. Scenarios 4 and 6 follow a similar pattern as Scenario 2. These scenarios have been grouped below to show the average highest toll fee per mile and average highest toll fee per hour that drivers are willing to pay for increased reliability. Table 14 shows this grouping of three scenarios to demonstrate the variance in the VOR factor.

Table 14. Stated-preference Scenarios for VOR Factor

Scenario No. (Route key factor)	Scenario 2 (VOR)	Scenario 4 (VOR)	Scenario 7 (VOR)
Origin	Port of LB on I-710	Long Beach on I-405	Los Angeles on I-110
Destination	Santa Fe Springs	Van Nuys	Pasadena
Distance (miles)	20	45	30
Average Speed (mph)	40	30	30
Travel Time (minutes)	30	90	60
Toll Charges (USD)	10	15	15

Table 15 tabulates the tolerated toll fee results on the VOR factor in terms of $ per mile and $ an hour. It is found that the average value of $ per mile during weekdays (0.497) accounts for a 12.34% increase over the average value for Scenarios 2, 4, and 7 during the weekend (0.442). Also, it is found that the average value of $ an hour during weekdays (16.657) accounts for a 12.12% increase over the average value for Scenarios 2, 4, and 7 during the weekend (14.857). Additionally, the highest toll fee per mile on any day that drivers are willing to pay when the main factor being compared is the VOR factor is $0.47 per mile. In other words, the highest toll fee per hour on any day that drivers are willing to pay when the main factor being compared is the VOR factor is $15.76 an hour.

Table 15. Results on Estimation for VOR Factor

Scenario No.	$/Mile (Weekday)	$/Mile (Weekend)	$/hr. (Weekday)	$/hr. (Weekend)
2	0.53	0.48	21.11	19.16
4	0.38	0.34	11.39	10.06
7	0.58	0.51	17.47	15.36
Column Average	0.497	0.442	16.657	14.857
Weekday/Weekend Average	0.47		15.76	

5.7 Results: Safety Scenarios

Scenarios 6, 8, and 9 vary in the aforementioned route characteristics and compare the safety factor as a key factor. The survey describes safety as a key factor in terms of the time of day of the trip, the presence or absence of passenger cars, and weather conditions such as heavy rain or no rain. Consequently, Scenarios 6, 8, and 9 have been grouped below to show the differences in route characteristics. Table 16 shows the grouping of three scenarios to demonstrate the variance in the safety factor.

Table 16. Stated-preference Scenarios for Safety Factor

Scenario No. (Route key factor)	Scenario 6 (Safety)	Scenario 8 (Safety)	Scenario 9 (Safety)
Origin	Port of LA on I-5	Port of LB on I-710	Port of LA on I-110
Destination	San Diego	Santa Fe Springs	Pasadena
Distance (miles)	120	20	20
Travel Time (minutes)	60	60	50
Average Speed (mph)	120	20	35
Toll Charges (USD)	5	5	5

Table 17 shows the tolerated toll fee results on safety factor in terms of $ per mile and $ an hour. It is found that the average value of $/mile during weekday (0.182) accounts for a 11.68% increase over the average value for Scenarios 6, 8, and 9 during the weekend (0.163). Also, it is found that the average value of $ an hour during weekday (10.321) accounts for a 11.12% increase over the average value for Scenarios 6, 8, and 9 during the weekend (9.288). Additionally, the highest toll fee per mile on any day that drivers are willing to pay when the main factor being compared is the safety factor is $0.17 per mile. In other words, the highest toll fee per hour on any day that drivers are willing to pay when the main factor being compared is the safety factor is $9.80 an hour.

Table 17. Results on Estimation for Safety Factor

Scenario No.	$/Mile (Weekday)	$/Mile (Weekend)	$/hr. (Weekday)	$/hr. (Weekend)
6	0.05	0.05	3.27	3.04
8	0.29	0.26	17.33	15.60
9	0.20	0.18	10.36	9.22
Column Average	0.182	0.163	10.321	9.288
Weekday/Weekend Average	0.17		9.80	

Table 18 summarizes the comparison results of values for tolerated toll fee per mile and toll fee per hour metrics as they relate to VOT, VOR, and safety factors. For all values, a difference was found in drivers' willingness to pay for tolls when comparing weekday and weekend usage. When using VOR as a key comparison factor, the results indicate that drivers value reliability ($0.47 per mile) approximately three times as much as they value safety ($0.17 per mile) when measured in toll fee per mile. When measuring in toll fees per hour, drivers' VOR ($15.76 an hour) is approximately 1.5 times their value for safety ($9.8 an hour).

When comparing in toll fee per mile, VOT ($0.54 per mile), and VOR ($0.47 per mile) drivers value time and reliability similarly. However, when measured in toll fees per hour, with a VOT of $32.38 an hour and a VOR of $15.76 an hour, the results indicate that drivers' willingness to pay for time is approximately twice the value for reliability. This result indicates that from the same point of origin and destination, drivers showed a different willingness to pay for time and reliability. Of the three key comparison factors, in terms of toll fees per mile, drivers are least willing to pay for tolls when using safety as a key comparison factor and most willing when considering the time factor to be the key comparison factor. In all cases, drivers' valuations of the time factor outweigh their valuation of reliability and safety.

Table 18. Summary of Results on Key Factor

Route factor (Scenarios)	$/Mile (Average)	% Difference (Weekend and weekday)	$/hr. (Average)	% Difference (Weekend and weekday)
VOT (1, 3, 5)	0.54	12.44%	32.38	12.44%
VOR (2, 4, 7)	0.47	10.99%	15.76	10.81%
Safety (6, 8, 9)	0.17	10.06%	9.80	10.01%

5. Conclusions

This research implemented the stated-preference survey method in the field to estimate the value placed on time, reliability, and safety by both company truck drivers and owner-operator truck drivers when choosing among travel routes. The statistical analysis used a complete set of 45 stated-preference survey responses obtained from both company truck drivers and owner-operator truck drivers and yielded the following findings.

(1) The tolerated toll fees that both company truck drivers and owner-operator truck drivers combined were willing to pay ranged from $3.27 an hour to $41.45 an hour with an average of $20.50 an hour during weekdays, while those fees range from $3.04 an hour to $36.12 an hour with an average of $18.12 an hour during weekends. The tolerated toll fees that owner-operator truck drivers were willing to pay ranged from $3.40 an hour to $37.93 an hour with an average of $19.18 an hour during weekdays, while those fees range from $3.20 an hour to $32.6 an hour with an average of $16.31 an hour during weekends. The tolerated toll fees that company truck drivers were willing to pay ranged from $3.16 an hour to $44.27 an hour with an average of $21.56 an hour during weekdays, while those fees range from $2.92 an hour to $38.93 an hour with an average of $19.58 an hour during weekends.

(2) The data analysis showed that owner-operator truck drivers and company truck drivers are not willing to pay toll fees for the routes used in six comparisons out of nine despite sharing a common origin and destination. The rationale is that they consider the priority among the three route choice characteristics of safety, value of time (VOT), and value of reliability (VOR). These results indicate that the factors of route characteristics are more important than the route considered, regardless of origin and destination.

(3) The data analysis demonstrated that company truck drivers do not show differences from owner-operator truck drivers in their tolerance to pay toll fees on truck-only lanes when evaluating the same route and scenario. This leads to the conclusion that truck drivers, regardless of type of ownership, value a route with truck only-lanes in a similar way.

(4) The highest toll fee per mile on any day that drivers are willing to pay when the main factor being compared is VOT is $0.54 per mile or $32.38 an hour. The figures for the VOR and safety factors are $0.47 per mile or $15.76 an hour and $0.17 per mile or $9.80 an hour, respectively.

When using VOT as a key comparison factor, the results also indicate that drivers value time similarly to the way they value reliability when measured in toll fees per mile. However, when measuring in toll fees per hour, drivers' value of time is more than 1.5 times greater than their value of reliability, and more than 3 times greater than their value of safety. Of the three key comparison factors, in terms of toll fee per mile, drivers are most willing to pay for tolls when using VOT as a key comparison factor and least willing to pay when considering the safety factor to be the key comparison factor. In all cases, drivers' value for the time factor outweighs their value of reliability and safety.

While this report has presented transportation agencies with meaningful data on company truck drivers' and owner-operator truck drivers' behaviors and patterns, several critical limitations remain. Some of the open research areas to address these limitations include:

- The need to obtain more data on truck drivers in other areas outside the Ports of LA and LB. As mentioned in this study's boundaries, the Southern California freight system also consists of truck drivers that are moving goods to distribution centers inside the SCAG six-county region.
- The need to expand this work to encompass other categorizations of truck drivers. This research classified truck drivers by the type of ownership: owner-operator truck drivers or company driver. Nonetheless, an alternative type of truck driver classification is the type of cargo that the truck is hauling—dry van, refrigerated, dry tanker, liquid tanker, hazardous materials, and oversized loads. Thus, a comparative study including classification by type of cargo will help to better understand travel patterns and route choice according to the priority or difficulty of moving certain types of cargo.

Appendix A: Stated-preference Survey

Figure 7. SP Survey Preliminary Questions

PART I. Preliminary Questions

	I own the truck	Company truck
Who owns the truck that you operate?	O	O

	YES	NO
Do you ever go to the Port of Long Beach and Port of Los Angeles?	O	O

	2	3	4	5	6	7 or more
How many axles does your vehicle have?	O	O	O	O	O	O

	1-5 years	6-10 years	11-15 years	16-20 years	21-more years
How many years of experience do you have?	O	O	O	O	O

Figure 8. SP Survey Questionnaire for Scenario 1

Part II. Value of time, safety and reliability

SCENARIO 1: Consider the scenario presented below and answer the following questions.

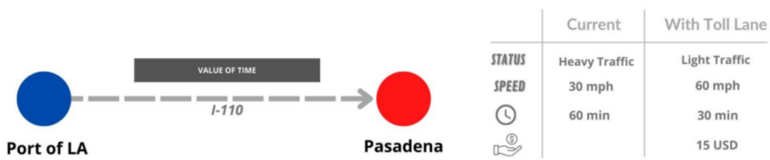


Figure 1.

Do you prefer this toll charge?

- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$5	$10	$15	$20	$25	$30
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 9. SP Survey Questionnaire for Scenario 2

SCENARIO 2: Consider the scenario presented below and answer the following questions.

Figure 2.

Do you prefer this toll charge?

- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$2	$5	$8	$10	$15	$20
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 10. SP Survey Questionnaire for Scenario 3

SCENARIO 3: **Consider the scenario presented below and answer the following questions.**

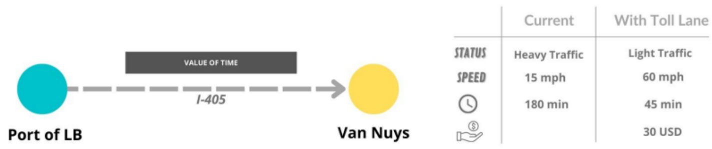


Figure 3.

Do you prefer this toll charge?

- YES
- NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$10	$20	$30	$40	$50	$60
Weekday (Mon-Thu)	O	O	O	O	O	O
Weekend (Fri-Sun)	O	O	O	O	O	O

Figure 11. SP Survey Questionnaire for Scenario 4

SCENARIO 4: **Consider the scenario presented below and answer the following questions.**

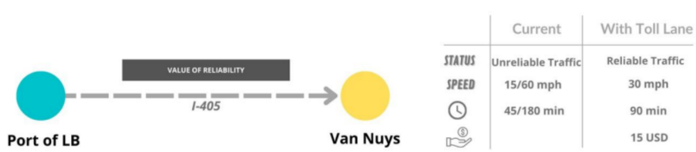


Figure 4.

Do you prefer this toll charge?

- YES
- NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$5	$10	$15	$20	$30	$40
Weekday (Mon-Thu)	O	O	O	O	O	O
Weekend (Fri-Sun)	O	O	O	O	O	O

Figure 12. SP Survey Questionnaire for Scenario 5

SCENARIO 5: Consider the scenario presented below and answer the following questions.

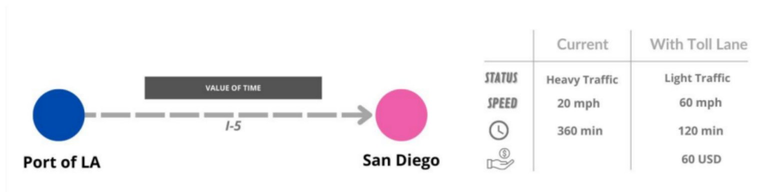


Figure 5.

Do you prefer this toll charge?

- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$15	$30	$45	$60	$90	$120
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 13. SP Survey Questionnaire for Scenario 6

SCENARIO 6: Consider the scenario presented below and answer the following questions.

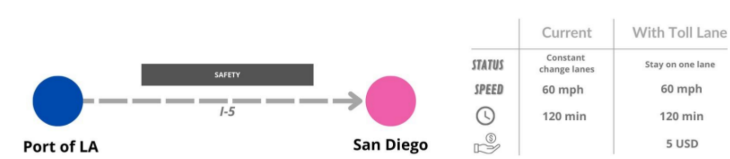


Figure 6.

Do you prefer this toll charge?

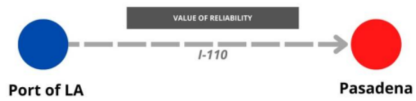
- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$0	$2	$4	$6	$8	$10
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 14. SP Survey Questionnaire for Scenario 7

<u>SCENARIO 7:</u> Consider the scenario presented below and answer the following questions.



	Current	With Toll Lane
STATUS	Unreliable Traffic	Reliable Traffic
SPEED	20/45 mph	30 mph
(time)	40/90 min	60 min
(toll)		15 USD

Figure 7.

Do you prefer this toll charge?

- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$5	$10	$15	$20	$30	$40
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 15. SP survey questionnaire for scenario 8

<u>SCENARIO 8:</u> Consider the scenario presented below and answer the following questions.

	Current	With Toll Lane
STATUS	Heavy Rain	No Rain
SPEED	30 mph	50 mph
(time)	40 min	20 min
(toll)		5 USD

Figure 8.

Do you prefer this toll charge?

- ○ YES
- ○ NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$0	$2	$4	$6	$8	$10
Weekday (Mon-Thu)	○	○	○	○	○	○
Weekend (Fri-Sun)	○	○	○	○	○	○

Figure 16. SP Survey Questionnaire for Scenario 9

<u>SCENARIO 9:</u> Consider the scenario presented below and answer the following questions.

	Current	With Toll Lane
STATUS	Night Time	Daytime
SPEED	50 mph	50 mph
	35 min	35 min
		5 USD

Figure 9.

Do you prefer this toll charge?

- YES
- NO

At most, how much would your client be willing to pay for this toll on your behalf?

	$0	$2	$4	$6	$8	$10
Weekday (Mon-Thu)	O	O	O	O	O	O
Weekend (Fri-Sun)	O	O	O	O	O	O

Abbreviations and Acronyms

ANOVA	Analysis of Variance
IRB	Institutional Research Board
LM	Logit Model
MRS	Marginal Rate of Substitution
RP	Revealed Preference
SCAG	Southern California Association of Governments
SP	Stated Preference
VOT	Valuation of Time
VOR	Value of Travel Reliability
WR	Wage Rate

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