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16. Abstract In Texas, where traditional funding lags behind needs to maintain and improve the state's infrastructure, much of the state's new highway capacity is being financed through tolls. With Texas's major cities already among the nation's most congested, considerable growth in both population and freight expected, and opportunities for capacity expansion limited by environmental and land-use concerns, it is likely that applications of road pricing to better manage existing capacity will be also necessary in the future. Little research has been performed to examine truck response to road pricing, and it is clear from the few studies that have been performed that this response is highly variable depending on location, industry sector, commodity type, and trip distance. The purpose of this study is to identify and quantify how the different segments of the trucking industry would respond to road pricing applications, including traditional toll roads, variably priced toll roads, mixed-use express lane facilities, and truck-only tolled facilities. Industry variables that will be examined include truck load type, trip distance, commodity, and familiarity with toll roads.			
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**RESPONSES OF TRUCKING OPERATIONS
TO ROAD PRICING IN CENTRAL TEXAS**

by

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Research Report SWUTC/10/476660-00066-1

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ABSTRACT

In Texas, where traditional funding lags behind needs to maintain and improve the state's infrastructure, much of the state's new highway capacity is being financed through tolls. With Texas's major cities already among the nation's most congested, considerable growth in both population and freight expected, and opportunities for capacity expansion limited by environmental and land-use concerns, it is likely that applications of road pricing to better manage existing capacity will be also necessary in the future. Little research has been performed to examine truck response to road pricing, and it is clear from the few studies that have been performed that this response is highly variable depending on location, industry sector, commodity type, and trip distance. The purpose of this study is to identify and quantify how the different segments of the trucking industry would respond to road pricing applications, including traditional toll roads, variably priced toll roads, mixed-use express lane facilities, and truck-only tolled facilities. Industry variables that will be examined include truck load type, trip distance, commodity, and familiarity with toll roads.

EXECUTIVE SUMMARY

Roads are a key component to any region's transportation system, providing for its overall accessibility and economic growth. But when the road system is poorly funded, it can result in billions of dollars in wasted fuel and environmental costs among others. In Texas for example, insufficient transportation funding has resulted in some of the major cities being among the most congested in the nation.

One option that has been used to address this funding gap is to finance new roads and increase the capacity of existing roads through investments in toll roads either by a public agency or by concessions to the private sector. Toll roads are already operational in Austin, Dallas-Fort Worth, and Houston, and a number of additional projects are in the planning and construction stages. As the state's largest cities continue to see significant population growth, congestion, which is already among the worst in the nation, is only expected to escalate. And major growth in international trade projected, and shifting of new container traffic to Mexican and Gulf Coast ports expected, it is clear that Texas will also need to provide capacity and efficiency improvements to meet future highway freight needs.

Although trucking demand is considered a very important factor in planning for highway infrastructure, little research has been performed to examine truck response to road pricing. The few studies that have been performed show conflicting results and substantial variability based on location, industry sector, commodity type, and trip distance. These studies tend to be location specific, and their results cannot be generalized.

Although truck volumes are usually approximated to be a small percentage of the traffic using a toll road (around 10%), the revenue they account for can be between 24 to 30%

since trucks pay a higher toll rate. An overestimation of truck traffic results in lower revenues and increases the risks about the feasibility of toll roads.

Previous studies have concluded that truck sector's response to road pricing is highly variable; it depends on location, industry sector, commodity type, and trip distance. This research study attempt was to be able to characterize truck toll road users and non-toll road users in the Central Texas toll road area. The research team conducted a survey of truck carriers to determine the general characteristics of the trucking sector as well to their perception of toll roads to be able differentiate between both groups. The main objective of this research was to understand the decision-making process and the behavioral responses of goods movement businesses to tolls charged on facilities.

Due to the great differences among different types of truck carriers, their responses to truck tolling were, without a doubt, expected to be different – each sector responding to their own needs and financial capacities. The trucking sector was segmented in terms of:

- Service area, i.e., local, regional, national, and international (e.g., cross-border U.S.-Canada and U.S. Mexico shipments),
- Trip type, intra-regional, inter-regional, and through trips,
- Vehicle ownership (i.e., owner-operator, company drivers),
- Company size (i.e., small less than five trucks, medium, and large national companies),
- Vehicle characteristics (i.e., light, medium, heavy, and specialized trucks), and
- Type of carrier/operation (i.e., truckload for hire, less than truckload for hire, local delivery, parcel/express, private fleet, and specialized services).

The survey contained a total of 43 questions divided into four parts: company; operation; categorization between toll road users or non-users, different questions regarding toll roads were asked depending if they were a user or a non-user; and, respondents'

perception of toll roads. It was developed as a web-based survey using Zoomerang, an online survey software tool. A web link to the survey along with information about the study was published in the TMTA weekly newsletter during the month of March 2009. In addition to the TMTA newsletter posting, the survey was deployed by emails to contacts obtained through the years from several trucking industry seminars previously attended by members of the research team and to TMTA members, as well as through phone interviews.

A total of 112 valid responses were collected representing the following trucking sectors: Less-Than-Truckload (LTL), Truckload (TL), Private, Owner-Operators, Parcel and Express and Others. This latter group includes Specialized, Intermodal, and Heavy haulers. The sector that was most represented was the TL sector constituting 31% of the total responses. This was to be expected since this sector has the highest representation at a national level. The research team noted that the Private carriers, which represented 21% of the responses, tend to be more willing and accessible to answer the survey than LTL carriers, which only consisted of 12% of the respondents.

Through the responses obtained from the surveys, the research team was able to characterized truckers by type of trucking operation and whether or not they were toll road users. Some of the most relevant findings were:

- most truck carriers belief their operation to be impacted negatively due to congestion,
- the majority of truck carriers transport a time sensitive commodity and have to operate within a specified delivery,
- most of the toll road users indicated time savings as a major benefit in using toll roads,
- most toll road user fleets are equipped with an electronic toll tag and it is the company that is in charge of paying for the toll,
- most drivers are allowed to use toll roads all the time or by their own discretion,

- the two major reason for not using a toll road were either because none are available in their area or because the costs are too high,
- the majority of the non-toll road users are willing to pay a for the use of a toll road in order to avoid congestion,
- most non-toll road users would consider using a toll road if a fuel tax refund were implemented for the miles travel on a toll road.

The statistical analysis did conclude that there are significant different in the perception of toll roads between a toll user and a non-user.

When providing non-toll road users with incentives that would divert them to a toll road the researchers found a very strong negative sentiment towards toll road in general. Very few respondents were willing to even answer these questions and most of those that did respond were either not interested in any incentive or stated that they may be interested. The incentive that resulted in the most positive response was the provision of a fuel tax refund for the miles traveled on a toll road.

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CHAPTER 1. INTRODUCTION

Roads are a key component to any region's transportation system, providing for its overall accessibility and economic growth. But when the road system is poorly funded, it can result in billions of dollars in wasted fuel and environmental costs among others. In Texas for example, insufficient transportation funding has resulted in some of the major cities being among the most congested in the nation.

Since the creation of the Highway Trust Fund in the 1950's, transportation funding has almost exclusively been dependent on federal and state fuel taxes. These fuel taxes, seen as an indirect charge to recover the costs of vehicle travel on the U.S. highway system, seemed reasonable at the time they were imposed, but they have failed to keep up with demand and maintenance and construction costs that have increased faster than the inflation rate. Add to this equation the fact that the modern vehicle fleet is more fuel efficient and that population growth has increased the demand for transportation and it all results in inadequate funding to maintain and expand an aging road system.

One option that has been used to address this funding gap is to finance new roads and increase the capacity of existing roads through investments in toll roads either by a public agency or by concessions to the private sector. In Texas, where traditional funding sources are becoming increasingly inadequate to modernize and maintain the state's infrastructure, the state is increasingly looking towards public and private investment in toll roads to quickly deliver highway capacity improvements sooner. Toll roads are already operational in Austin, Dallas-Fort Worth, and Houston, and a number of additional projects are in the planning and construction stages. As the state's largest cities¹ continue to see significant population growth, congestion, which is already among the worst in the nation, is only expected to escalate. And major growth in international trade projected, and shifting of new container traffic to Mexican and Gulf Coast ports expected, it is clear that Texas will also need to provide capacity and efficiency improvements to meet future highway freight needs.

¹ According to the TTI Urban Mobility Report, Dallas and Houston are among the most congested cities in the nation, and Austin is by far the most congested city of its size in the U.S.

Although trucking demand is considered a very important factor in planning for highway infrastructure, little research has been performed to examine truck response to road pricing. The few studies that have been performed show conflicting results and substantial variability based on location, industry sector, commodity type, and trip distance. These studies tend to be location specific, and their results cannot be generalized (see Chapter 2).

The development of toll roads – whether public or private – depends on the selling of bonds. A number of studies by bond rating agencies have shown that a majority of toll roads have failed to meet revenue expectations in their first full year of operation. These studies alluded to the existence of an optimism bias in T&R forecasts, with an over estimation of traffic by 20-30 percent in the first five years of operation. Although truck volumes are usually approximated to be a small percentage of the traffic using a toll road (around 10%), the revenue they account for can be between 24 to 30% since trucks pay a higher toll rate. An overestimation of truck traffic results in lower revenues and increases the risks about the feasibility of toll roads, resulting in higher interest payments and the facility being down rated (Standard & Poor's, 2005).

The study team conducted a survey of truck carriers to improve the understanding of trucker's responses to pricing applications. The following report provides an account on how the survey was conducted and on the general characteristics of the respondents – i.e. type of operation, size of fleet. This report categorizes respondents as either a toll road user or a non-toll road user and analyses the different responses obtain for each group. Researchers also conducted a comparison amongst of the major differences between each group.

CHAPTER 2. BACKGROUND

2.1 LITERATURE REVIEW

To understand the trucking sector and their different responses to road pricing applications an extensive literature review was conducted. This Chapter of the report summarizes the salient findings of these studies.

In 2003 Holguin Veras's research team analyzed the economic and financial feasibility of heavy-truck toll lanes (HTL). The concept of the HTL presented in this study involved the use of a separate facility, an increase in the weight limits and truck sizes; financing the construction and operation through private investments (tolls); and rebates on gas taxes to trucks using the facility. The study concluded that an increase in gross weight limits will lead to an increase in payloads, thus, impacting operational costs. For HTLs to be financially feasible the tolls need to be between \$0.25 and \$0.50/km to generate a higher rate of return than the opportunity cost of the capital. Return on investment (ROI) is sensitive to the amount of daily traffic and to the initial investment, but are good investment opportunities for the private sector. The feasibility analyses determined that even with low traffic levels, the HTLs will have a positive economic effect and this will increase as traffic levels increase. The effect of a change in the initial investment hardly affects the economic feasibility.

Holguin-Veras (2007) researched the effects of the time-of-day pricing initiative implemented by the Port Authority of New York and New Jersey (PANYNJ) as a means to finance their capital budget, reduce congestion, increase the use of mass transit and E-ZPass, and ease commercial traffic management. As part of the study, the research team conducted surveys that tried to capture the behavioral responses of two groups of users – i.e., passenger and commercial vehicles – to the pricing initiative. The carrier survey focused on companies located in New York and New Jersey and gathered data about the company attributes, behavioral changes after the time-of-day pricing initiative, current operation and travel flexibility, their usage of E-ZPass, and awareness of toll discounts.

Of the 200 observations, 20.2 % indicated that they had made changes in their behavior, following the time of day pricing initiative. Those that changed their operations seem to represent Full Truckload (FTL) operations since these companies have more route alternatives. Local deliverers usually do not have many alternatives since they would require the approval of receivers to change their time of travel. Respondents that did not change behavior indicated that they did not have any time-of-arrival flexibility (usually for-hire carriers). Most of the regular users are currently using E-ZPass to travel through the toll facilities, but they were not fully aware of the toll discounts available.

Adelakun and Cherry (2008) focused on truck drivers' perceptions of urban congestion and safety challenges, and tried to identify truck preferences given potential geometric or operational solutions. Of the 500 truck drivers interviewed at a truck plaza, 47% of the respondents were owner operators and 53% worked for a trucking company. Both types of truck drivers agreed that they experience severe congestion through the area, but only half indicated that they changed their itineraries or routes to avoid it. In terms of safety and efficiency, most truck drivers indicated that the greatest threat to their productivity and safety were aggressive drivers, lane changing behavior, congestion, and merging cars. When asked about lane configurations, most respondents supported the use of left side lanes as truck lanes (reversing the current lane configuration). There was also great support for the option of a managed truck only lane. However, the drivers that supported optional truck only lanes were not willing to pay more to avoid congestion than those that supported other operational changes. The average willingness to pay to save ten minutes of travel time was \$2. This results in an average value of time, from the truck driver's perspective, of \$10 per hour.

Short (2007) explored the willingness of truck carriers to pay for the use of an optional truck only toll (TOT) lane on the Atlanta interstate highways. The researches interviewed 71 Georgia based trucking firms to characterize their use of highways, their time of travel, the possibility of using alternative routes, the criticality of their shipments, and their willingness to increase costs in exchange for real or perceived benefits from using the TOT system. The survey results suggested interest in an increase in capacity and congestion mitigation, especially the use of TOT lanes if these were non-tolled. This means that a pricing mechanism is required for a TOT lane

to operate at free-flow speeds. Finally, the researchers pointed out that shippers usually establish delivery times and require for carriers to travel during peak hours, this indicates that congestion will continue to be a problem in spite of the carriers changing behavior, and it is shippers' behavior that needs to be influenced.

In this study Poole, et. al. (2002) proposed the use of self-financing toll truckways consisting of one or more truck only lanes (each way) and physically separated from existing lanes by New Jersey concrete barriers, as a way to mitigate the current system's conflicts between passenger vehicles and trucks. These proposed truckways will allow for the use of longer and heavier trucks – thereby greatly increasing freight productivity and greatly reducing the amount of money that it would take to improve the existing system to allow for greater use of longer combination vehicles (LCVs).

Along with the increase in transportation efficiency, there will also be an increase in safety issues, since trucks and passenger vehicles will be physically separated. An increase in productivity will yield an increase in revenue that could promote the funding of improved safety features, for example use of high technology to help truck drivers become safer and more productive. There will also be environmental benefits from using LCVs since they would reduce vehicle miles traveled, fuel consumption, and emissions. Although there will be cost saving benefits from allowing the LCVs to operate on the existing mixed traffic facilities, the cost of upgrading it to the necessary standards will be too high. It is more economical to build a new truck lane or convert and upgrade an existing lane for truck only use than to upgrade all lanes.

Geiselbrecht et. al. (2008) researched the possibility of using innovative pricing incentives as a means to encourage truck carriers to use the SH 130 toll road in Austin as an alternative route to congested I-35. The researchers developed and administered both an online and a paper survey of which a total of 2,023 valid responses were obtained. The survey focused on classification of type of operation, delivery flexibility, travel behavior, and perceptions of proposed incentives and travel scenarios. Results showed that drivers plan to avoid congestion and that the incentives that were most favored were those that directly impact costs, such as reduced fuel price and off-peak discounts. The researchers subsequently analyzed the potential costs and benefits for the

truck companies associated with the preferred incentives using SH 130 and the added cost of the incentive to the toll road operator. These costs were estimated for the year 2015, the year in which congestion of I-35 is predicted to reach its peak and therefore drawing more truckers to use the SH 130 toll road. From the survey the research team obtained a value of time of \$34.49/hour and time savings for the completed SH 130 were estimated to be between 11.6 minutes in off-peak hours, between 33.6 and 47.7 minutes in the AM peak hour and between 13.9 and 19 minutes Southbound and between 36.9 and 51.7 Northbound in the PM peak hour. The estimated benefit cost ratio was 1.36, suggesting that although offering incentives to shift truck traffic to the toll road could have a positive impact the overall implementation costs could ultimately result in the costs outweighing the benefits.

CHAPTER 3. THE TRUCKING SECTOR

In 2007, the trucking industry accounted for 10.7 billion tons of the United States freight movement – about 66% of all the tons of freight transported and \$8.4 trillion – or more than 70% of the value of all of freight transported for that year. (BTS, 2008) Given the importance of this industry sector to the nation’s economy, it is important to understand its different segments and structure when any policy decision that could affect their operation is being considered.

Recently, many states have started to look into road pricing as a means of both financing new highway capacity and managing existing capacity. Road pricing, whether in the form of new highway capacity financed through tolls or management of lanes to achieve greater efficiency of the existing network, will play a role in providing necessary improvements in the future. Despite the substantial growth in truck freight traffic anticipated, little research has been done to determine the trucking industries’ response to road pricing. This is of great importance since truck traffic represents a relatively large percentage of toll revenue forecasts.

To determine the industry’s response it is important to recognize that the industry is not homogenous. Rather the industry can be categorized into a number of different sectors. In this study the trucking industry has been grouped into three carrier types:

- Private carriers,
- For-hire carriers, (including truckload, less-than truckload, parcel/express and specialized carriers)
- Owner operators.

Private carriers are carriers that have fleets owned by a particular manufacturer use to transport their own products. Examples of these types of carriers are Wal-Mart and HEB. For private carriers, toll roads can present a new way in which they can increase their productivity. Since they act as shippers, receivers and transportation service providers, the cost of using toll roads could be absorbed in the cost of the product they sell.

For-hire carriers are those that are hired by shippers to transport goods for a given compensation. These types of carriers can be subdivided into the type of load they carry such as truckload², less-than-truckload³, parcel/express⁴, and specialized carriers⁵. This group can be highly sensitive to any form of road pricing mechanism. Their operational structure makes it difficult for them to transfer the cost of using a toll road to the shipper or receiver. (AECOM, 2006).

Owner-Operators are independent drivers that own their trucks and are hired by shippers or other carriers to transport their goods. They typically operate as truckload carriers.

3.1 COST STRUCTURE

The different trucking segments have different operating and financial characteristics that will have different impacts on the way in which they conduct business and the decisions which they make when presented with route decisions (toll roads vs. non-toll roads). When making route decisions, trucking companies evaluate their total operating cost of travel, which includes both fixed and variable costs. In this study, fixed costs are identified as those costs that do not vary with the amount of travel. Fixed costs for the trucking industry include overhead, rent on buildings, and interest on loans. These types of costs are reduced as the output– e.g., vehicle miles traveled or ton-miles traveled– increases. Variable costs, on the other hand, are those costs

² Truckload (TL) carriers are those carriers that move full loads of freight, usually from one shipper to one receiver without having the need to sort the load in terminals. JB Hunt is an example of this type of carrier. Typical load sizes for a TL carrier are usually 10,000 pounds or more and the distances covered are usually more than 500 miles for long haul carriers and between 200 and 500 miles for medium or regional haul.

³ Carriers that carry less-than-truck loads (LTL) are those that deliver smaller shipments from more than one shipper to be delivered to more than one receiver. Shipments are picked up by a LTL driver along a regional route/service area and transported to a terminal. The shipments are then sorted and consolidated on a second truck that delivers the shipments to the final destination. Load sizes for LTL are around 500 to 2,000 pounds. An example of a LTL carrier is Yellow Freight. The cost structure for LTL carriers is more complex than that of a TL carrier due to the way in which their operation is set up. These types of carriers will have higher fixed and operating costs, which include increased overhead costs due to the handling of many smaller shipments; additional labor costs for dock personnel at receiving terminals and the costs of maintaining the terminal areas.

⁴ Parcel express carriers are those that are dedicated to the door-to-door delivery of small packages (less than 100 pounds). Some examples of parcel express carriers are Federal Express (FedEx) and DHL. These types of carriers conduct their business on a specific delivery time frame that ensures on-time delivery based on the customer's specifications. Road pricing initiatives could highly benefit parcel express carriers by providing more reliable travel times and thus improving their productivity.

⁵ For-hire carriers that focus on specialized operations, such as the transportation of chemicals or hazardous materials (Hazmat), as well as the transport of oversize/overweight loads are categorized as specialized operations. Specialized trucking firms have additional fixed and marginal costs associated with their type of operation, such as the need for specialized equipment and the cost of special permits associated with the commodity being transported.

that vary depending on the amount produce. The change in cost that results from the change in output by one unit is called the marginal cost.

This Chapter of the report highlights the findings of a literature review on studies that have analyzed the various costs of different trucking segments. Typically cost data have been obtained through surveys. The cost components are: driver wages and benefits, fuel and fuel taxes, truck maintenance, tires, depreciation, insurance, and administrative costs. This information can be used to estimate the operating cost per mile of the trucking companies.

The American Trucking Research Institute (ATRI) reported in a study entitled “*An Analysis of the Operational Costs of Trucking*” (2008) that driver costs have always been the highest marginal expense of the trucking industry. However, due to the increase in the price of fuel in 2008, diesel fuel cost per mile has exceeded the driver wage per mile. With diesel prices reaching \$4.79 per gallon in 2008, the results on the ATRI survey calculated that fuel and fuel taxes amount to \$0.69 per mile (ARTI, 2008).⁶ However, fuel prices have dropped considerably in the last months of 2008 and beginning of 2009, so that the cost of fuel was calculated at \$0.33 per mile given an average price of diesel of \$2.31 per gallon in 2008. For Owner-Operators, the cost of fuel and fuel taxes was calculated to be \$0.27 per mile by the Owner-Operators Independent Drivers Association (OOIDA) 2003 survey. Using the Consumer Price Index (CPI) for 2008 (215.303) to convert this value to a common base year, the fuel and fuel taxes cost per mile for the Owner-Operator carriers was calculated to be \$0.32 which is very close to the \$0.33 per mile value calculated for the other sectors.

The form in which drivers are compensated will depend on the carrier’s type of operation. A TL carrier usually pays a driver per mile driven, while LTL drivers are usually paid by the hour. According to ATRI (2008), drivers that are paid by the mile are paid on average 44.1 cents per mile. For those paid by the hour, the average pay was \$16.59 (ATRI, 2008). For owner-operators, the cost of driver salaries per mile is \$0.05, according to the results of the *2003 Cost of Operations Survey* conducted by the OOIDA. Converting this value to 2008 dollars would yield

⁶ This results concur with those computed following a Barnes and Langworthy (2004) estimate that trucks get around 7 miles to the gallon, which would yield a cost of \$0.68 per mile for fuel and fuel taxes.

a cost of \$0.06 per mile for Owner-Operator driver's salaries. At first glance, there appears to be a significant difference in these numbers, but it should be kept in mind that owner-operators usually do not pay themselves a wage, but rather share in the profit of the company.

In addition to wages, drivers are often provided performance bonuses as an incentive. Benefits that are also part of a driver's payment are Federal Insurance Contributions Act (FICA) tax, which is 7.5% of the total wage and unemployment taxes, in addition to any bonus payments. According to the 2008 survey, both these costs (bonuses and benefits) amount to a total of \$0.16 per mile. This value is similar to the \$0.15 per mile value presented by SKM in *Truck Operation Costs Outlook – Major Cause for Concern* (2008). In contrast, these costs for Owner-Operators only amounted to \$0.05 per mile in 2003, which would be equivalent to \$0.06 per mile in 2008. This difference in costs is to be expected since this type of carriers usually shares in the profits rather than paying themselves a bonus.

Repair and maintenance cost will vary by region and type of trucks. Specialized trucks have higher maintenance and repair costs. The average cost per mile reported by the ATRI (2008) study for all sectors was \$0.09. Another study conducted by Barnes and Langworthy (2004) concluded that maintenance and repair costs were \$0.11 per mile, that when converted to 2008 dollars, yields a cost of \$0.13 per mile. For Owner-Operators, the cost reported by the OOIDA survey (2003) was \$0.08 per mile, which would be equivalent to \$0.09 per mile in 2008.

The cost of tires varies greatly with the cost of oil since they are a petroleum based product. Cost of tires increased to \$0.03 per mile in 2008 with the escalated price of oil (ATRI, 2008). This cost is within the range of \$0.021 to \$0.04 per mile that was calculated by Barnes and Langworthy (2004) (\$0.03-\$0.05 in 2008 dollars). Tire costs also vary depending on the type of carrier. LTL carriers usually have a higher tire cost per mile than TL carriers. According to the ATRI survey, tire cost per mile for a LTL carrier is more than double the cost for a TL carrier. For Owner-Operators, the cost reported by the OOIDA survey (2003) was \$0.02 per mile – \$0.023 per mile when converted to 2008 dollars – a little less than the average cost for TL and LTL.

Although specialized carriers could have significantly higher costs for licensing and permits, depending if they transport Hazmat or oversize/overweight loads, the average cost for licensing and permits according to the 2008 ATRI survey was \$0.02 per mile. This cost is similar to that obtained by the ATA's *American Trucking Trends* (2005-2006) survey, which was an average of \$0.03 per mile and it is exactly the same as that calculated from the OOIDA 2003 survey (\$0.02 per mile); converting both these values to 2008 dollars results in a cost of \$0.033 per mile for the ATA values and \$0.023 per mile for the OOIDA values.

While insurance cost can be considered fixed costs, since it has to be paid even if the truck is not in use, ATRI considered it as a marginal cost because insurance coverage depends on the type and use of the vehicle. ATRI (2008) averaged the cost of insurance to be \$0.06 per mile. Again, TL carriers have the lowest insurance costs and specialized carriers can have up to 130% higher costs (ARTI, 2008). Since Owner-Operators are much smaller companies the cost of insurance calculated by the OOIDA survey (2003) was \$0.02 per mile, which is equivalent to \$0.023 per mile in 2008 dollars.

Table 3.1 presents a summary of the operating costs obtain from the literature review. The average cost per mile (converted to 2008 dollars) obtained was \$1.48. When considering that the average truck pays \$0.31 per mile to drive on a Central Texas toll road, this cost is equivalent to 21% of the total truck operating cost.

Table 3.1: Truck Operating Costs Per Mile

Costs in Dollars per Mile	ATA		ATA 2005-06	Barnes & Langworthy 2003	SKM 2008	ATRI 2008	OVIDA 2003
	2001	2003					
Driver wages	\$0.39	\$0.55				\$0.441	\$0.05
Fuel and Fuel Taxes	\$0.17	\$0.20		\$0.64		\$0.69	\$0.27
Outside Maintenance	\$0.06	\$0.07		\$0.105	\$0.097	\$0.092	\$0.08
Tax and License	\$0.03	\$0.03	\$0.03			\$0.024	\$0.02
Tires	\$0.02	\$0.02		\$0.021-\$0.04		\$0.03	\$0.02
Other Wages and Benefits	\$0.47	\$0.80			\$0.15	\$0.162	\$0.05
Depreciation	\$0.10	\$0.11	\$0.14		\$0.19		
Insurance	\$0.06	\$0.09			\$0.11	\$0.06	\$0.02
Interest	-	-			\$0.13		\$0.02
Administrative costs	-	-			\$0.03		\$0.01
Total Cost	\$1.30	\$1.87				\$1.499	\$0.55

CHAPTER 4. SURVEY METHODOLOGY

4.1 HYPOTHESIS

The main objective of this research was to understand the decision-making process (e.g., the factors considered) and the behavioral responses of goods movement businesses (i.e., trucking companies, shippers, and receivers) to tolls charged on facilities.

Due to the great differences among different types of truck carriers, their responses to truck tolling will, without a doubt, be different – each sector responding to their own needs and financial capacities. The trucking sector can be segmented in terms of:

- Service area, i.e., local, regional, national, and international (e.g., cross-border U.S.-Canada and U.S. Mexico shipments),
- Trip type, intra-regional, inter-regional, and through trips,
- Vehicle ownership (i.e., owner-operator, company drivers),
- Company size (i.e., small less than five trucks, medium, and large national companies),
- Vehicle characteristics (i.e., light, medium, heavy, and specialized trucks), and
- Type of carrier/operation (i.e., truckload for hire, less than truckload for hire, local delivery, parcel/express, private fleet, and specialized services).

Although these segments are not mutually exclusive, it is important to recognize the different segments when delineating the factors influencing a trucking company's decision to use or avoid a toll facility. For example, the cost structure and route choices of these segments are different. Local trucker's costs could be significantly increased by congestion. A local toll bridge or tunnel could thus see a high percentage of truck users, for the following reasons: (a) the tolled facility is on the shortest, fastest route to and from the trip's end points, (b) the toll charged is comparatively low compared to the incremental variable cost to operate on an alternative non-tolled route, and (c) everyone has to use the toll facility as no non-toll alternative exists. In other words, the cost of the toll does not have any competitive consequences. On the other hand, Knorring et al (2005) found that cost/benefit was a significant factor in the route selection of long haul truckers. These truckers will choose to pay a toll only if it makes business sense, i.e.,

the rates paid by the shipper allows the trucking company to recover the increased operating costs associated with using the toll or the savings in operating costs (time, fuel, etc.) exceed the additional cost imposed by the toll. Trucking companies also tend to support toll roads if the opportunity exists to use longer (and/or heavier) trucks and trailers (i.e., long combination vehicle, LCVs) on tolled facilities - thereby achieving economies of scale by operating one larger and heavier vehicle as opposed to having to make a second trip.

Of the for-hire carriers, the LTL carriers have a higher cost of service due to the nature of their shipments (many small shipments that make up one single truckload movement). This type of movement makes it harder for LTL carriers to allocate toll cost to specific shipments. On the other hand, LTL carriers usually conduct local movement of time sensitive commodities and would be benefited with the use of a toll road system than can provide an alternative route with a more predictable travel time than the congested 'free' alternative.

TL carriers usually conduct long haul movement allowing them to plan their trip accordingly so as to avoid crossing through congested cities during peak hours, making it easier for this type of carrier to be able to avoid toll roads.

In order to identify and quantify how the different segments of the trucking industry respond to road pricing applications a survey was conducted to different types of truck carriers. Industry variables that were examined include truck load type, trip distance, commodity, and familiarity with toll roads.

4.2 PILOT SURVEY

An initial questionnaire was developed and piloted during the months of September and October 2008 in Kerrville, Texas during two different workshops organized by the Texas Motor Transportation Association (TMTA), a local trucking association. A survey booth was set up during both workshops; participants that passed by the survey booth were approached to complete the survey. During the September workshop, which focused was on Safety, the research team had a greater response rate to the survey than in the Maintenance workshop conducted in October. This is probably due to the fact that during the Safety workshop the

research team was able to make a short presentation about the objectives of the study and asked event attendees to stop by the booth and complete the questionnaire. At least 25% of the event attendees completed the survey questionnaire (25 respondents). In contrast, during the Maintenance workshop, where the research team was not able to present the project and survey objectives to the attendees, the response rate was much lower (9 respondents).

4.3 WEB-BASED SURVEY

Based on the responses obtained in the pilot survey and after carrying out additional literature review, the original questionnaire was revised to simplify and clarify the wording and to add additional questions that would give us greater insight into truck carrier's behavioral response towards toll roads. This new questionnaire contained a total of 43 questions divided into four parts. The questions in the first part addressed question about the respondents company (e.g. type of operation, size of fleet, type of trucks used). The second part of the survey focused on the company's operation, whether it was long, medium or short haul, major commodities transported, delivery windows, time of deliveries, type of compensation, etc. The third part was used to categorize respondents as toll road users or non-users. Different questions regarding toll roads were asked depending if they were a user or a non-user. The final section of the survey focused on the respondents' perception of toll roads. An example of the survey is included in Appendix B.

The final survey was developed as a web-based survey using Zoomerang, an online survey software tool. A web link to the survey along with information about the study was published in the TMTA weekly newsletter during the month of March 2009. While the trucking industry's response to surveys is not very high according to the literature reviewed, an acceptable response rate was not obtained even though various attempts were made to attract more responses, such as changing the survey cover letter and republishing the survey in the newsletter in consecutive weeks during the period of March and May 2009.

Due to the initial low response rate achieved from the web-based survey individual e-mails were sent to 117 contacts obtained through the years from several trucking industry seminars previously attended by members of the research team. Of the total 117 e-mails sent, only 87

were successfully received and only 12 surveys were completed, yielding a response rate of 14%, which is much higher than that found in literature reviews.

In addition to the individual e-mails sent by the research team, the TMTA was asked to forward a cover e-mail and web link to the internet survey to their members to ask for their assistance in completing the survey. Although this attempt yielded a higher response rate than the newsletter – with a total of 19 completed surveys – it was still too low a number to achieve statistical significance. For that reason the research team decided to change the survey approach and began deploying phone interviews to different trucking companies. The contact information for the trucking companies was obtained from the Texas Department of Transportation Motor Carrier Database. A team member was in charge of calling the different contacts and asking to speak with either the owner or with someone in a managing position that is able to make operational decisions. Of the 2,340 trucking companies in the database that were tried to contact, only 30 valid responses could be included in the analysis. The survey used for the phone interviews was the same web-based survey published through Zoomerang.

4.4 STATISTICAL TESTS

Due to the low response rate obtain from the surveys; the sample size was not large enough to conduct many statistical analysis. A frequency analysis and a cross-tabulation analysis were conducted to compare nominal data. In order to determine whether toll road users were more likely to be biased in support towards toll roads a *Pearson's chi-square test* was applied. This statistical test, applied at a 95% confidence level, was computed as follows:

$$\chi^2 = \sum_{i=1}^n \frac{(O_i - E_i)^2}{E_i},$$

Where,

χ^2 = the test statistic that asymptotically approaches a χ^2 distribution,

O_i = the observed frequency,

E_i = the expected (theoretical) frequency, asserted by the null hypothesis, and

n = the number of possible outcomes of each event.

When conducting the Chi Square test, if the computed value for χ^2 is greater than the corresponding critical value at the 95% confidence level the null hypothesis is rejected and we

can state that there is indeed a bias from toll roads users towards their support of toll roads. In contrast, if the χ^2 value is less than the critical value the null hypothesis cannot be rejected and no inference can be made that would indicate a bias by toll road users and the support for toll roads.

To determine if there was any statistical significant difference (e.g. operational differences) between those that indicated being a toll road user and those that indicated being a non-toll road user an *inferences concerning a difference between sample proportions* statistical test was conducted. This test determines if there are differences in the proportions of the responses of toll road users and non-toll road users. In order to test any given null hypothesis for this test a Z-score is calculated using the following equation:

$$Z = \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\frac{\bar{p}\bar{q}}{n_1} + \frac{\bar{p}\bar{q}}{n_2}}}$$

Where,

p_1 and p_2 denotes the population proportions who possess a particular characteristic
 $p_1 - p_2 = 0$ (assumed in the null hypothesis)

$\hat{p}_1 = \frac{x_1}{n_1}$ and $\hat{p}_2 = \frac{x_2}{n_2}$ are the sample proportions or alternatively stated the number of successes in the sample divided by the size of the sample, and

$$\bar{p} = \frac{x_1 + x_2}{n_1 + n_2}, \bar{q} = 1 - \bar{p}$$

The value obtained for the Z-score is then converted to a P-value, which in turn is compared to the alpha value. If the P-value is smaller or equal to the alpha value, the null hypothesis can be rejected; hence, we can state that the difference between the proportions is significantly different.

4.5 CHARACTERISTICS OF TRUCKING COMPANY RESPONDENTS

When the survey was finalized, 112 valid responses had been collected representing the following trucking sectors: Less-Than-Truckload (LTL), Truckload (TL), Private, Owner-Operators, Parcel and Express and Others. This latter group includes Specialized, Intermodal, and Heavy haulers. As seen in Figure 4.1, the sector that was most represented was the TL sector constituting 31% of the total responses. This was to be expected since this sector has the highest representation at a national level. The research team noted that the Private carriers,

which represented 21% of the responses, tend to be more willing and accessible to answer the survey than LTL carriers, which only consisted of 12% of the respondents.

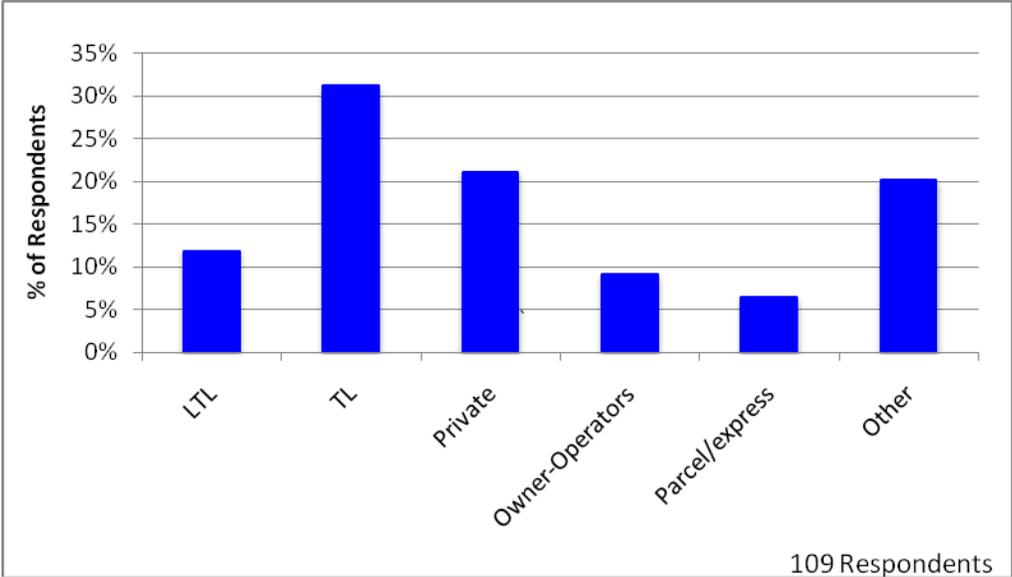


Figure 4.1 Type of Operation

To classify these different types of trucking sectors respondents were asked various questions pertaining to the size of the company (e.g. number of trucks, drivers), the type of trucks used, the distance traveled, the Texas county where they are located and the type of commodity transported. As seen in Figure 4.2, the truck type that is mostly used (the one that obtain the most responses) was the 5-axles single trailers to conduct their operation (35% of responses).

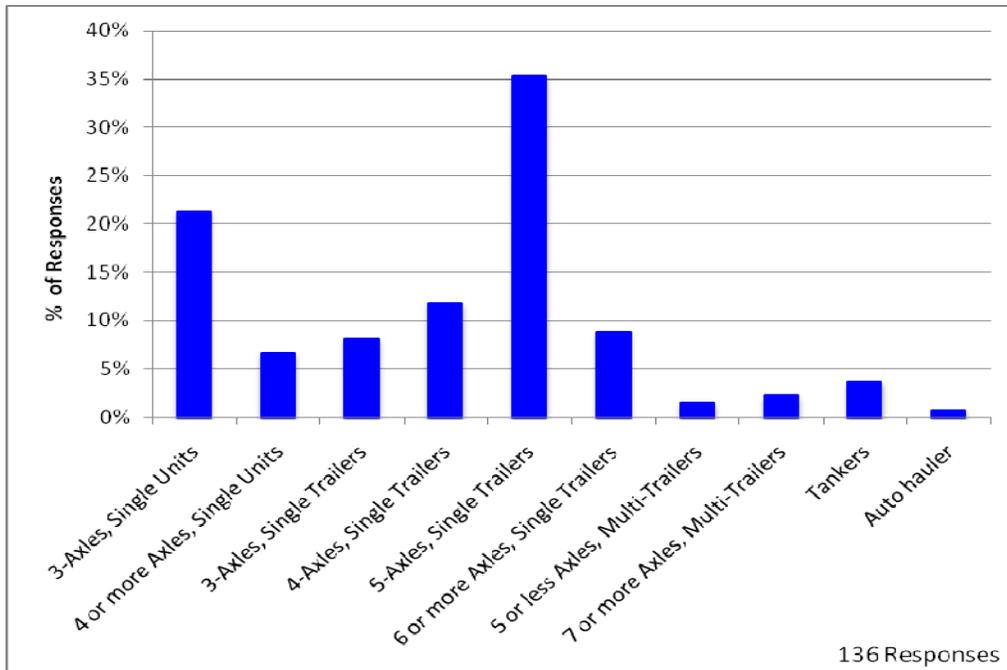


Figure 4.2 Truck Type

Survey respondents were asked to provide their company's number of single units, truck tractors, trailers and the number of drivers given a choice. Figures 4.3 through 4.6 illustrates the percentages obtain for each of these categories.

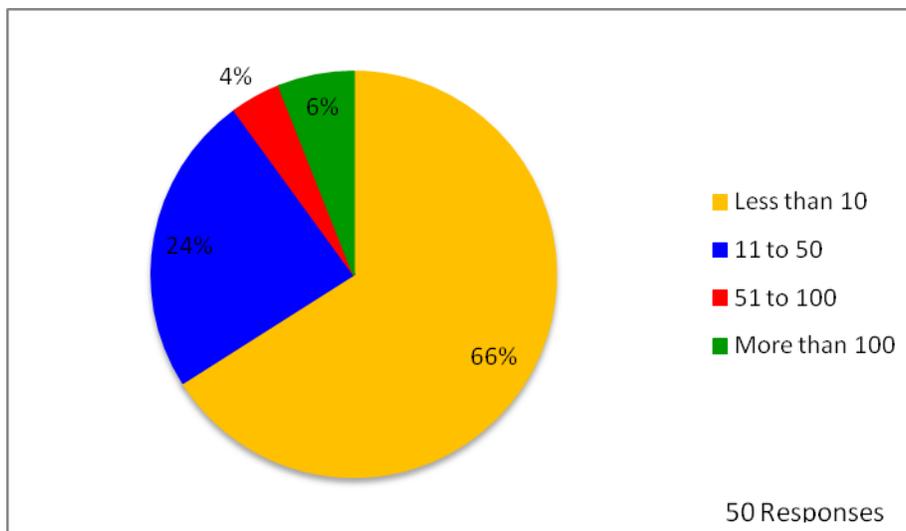


Figure 4.3 Percentage of Single Units

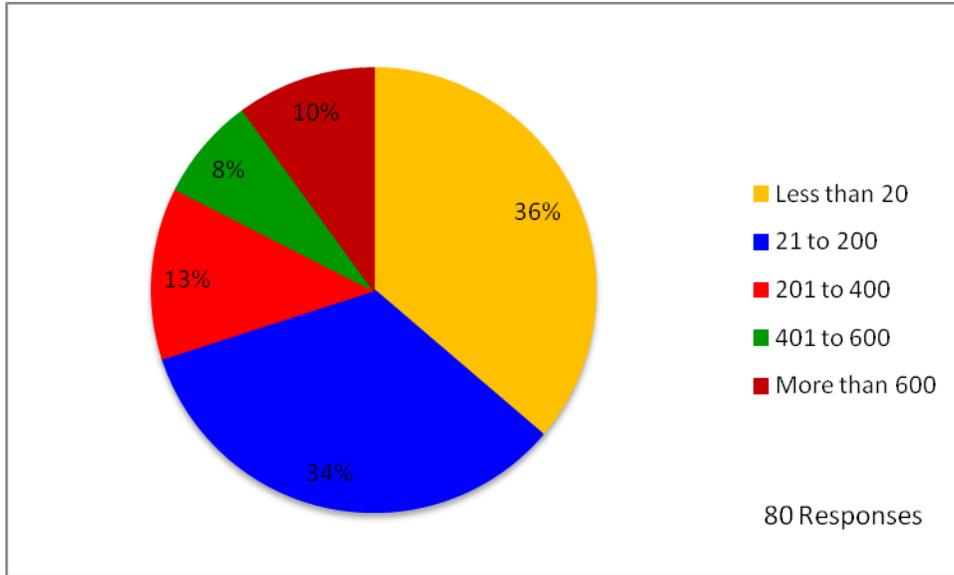


Figure 4.4 Percentage of Truck Tractors

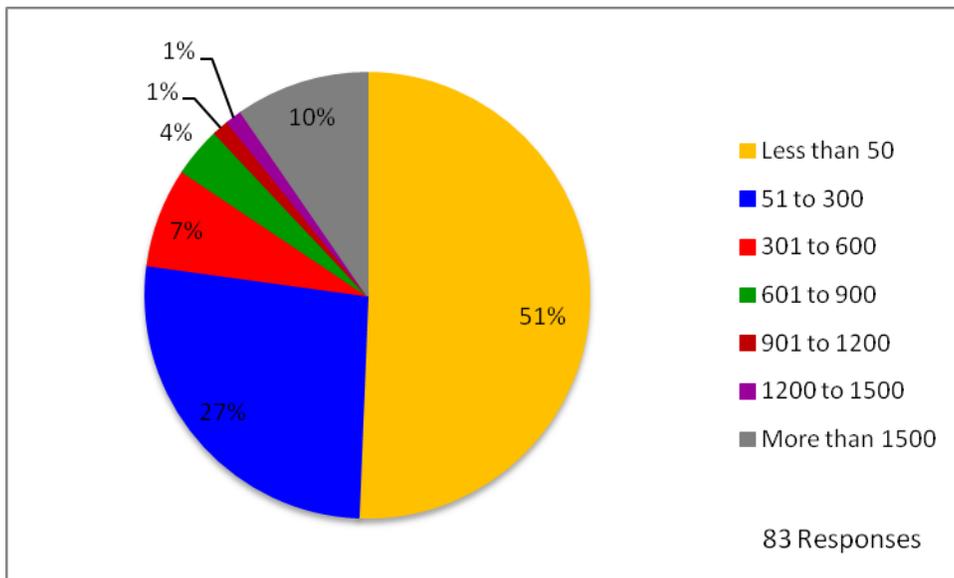


Figure 4.5 Percentage of Trailers

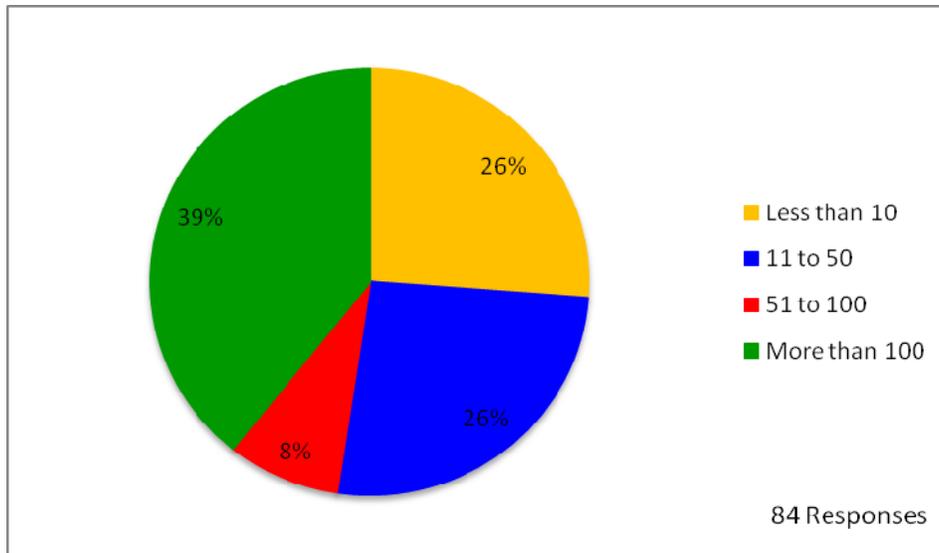


Figure 4.6 Percentage of Drivers

Respondents were asked to state where their main office was located. Conducting a frequency analysis (shown in Figure 4.7) of the answers obtained and mapping these, the researchers observed the the majority of the respondents had their main office located along the I-35 corridor (73% of respondents).

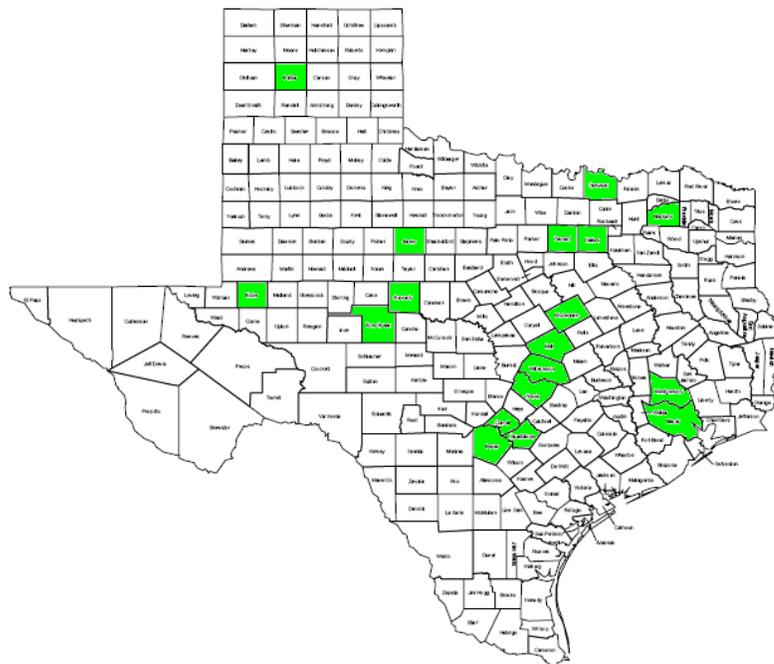


Figure 4.7 Location of Main Office by Counties

Respondents were asked what percentage of their business was comprised of local haul (less than 50 miles), short haul (50 to 200 miles), medium haul (201 to 500 miles) and long haul (more than 500 miles). Figures 4.8 through 4.11 illustrates the percentages obtain for each of these categories.

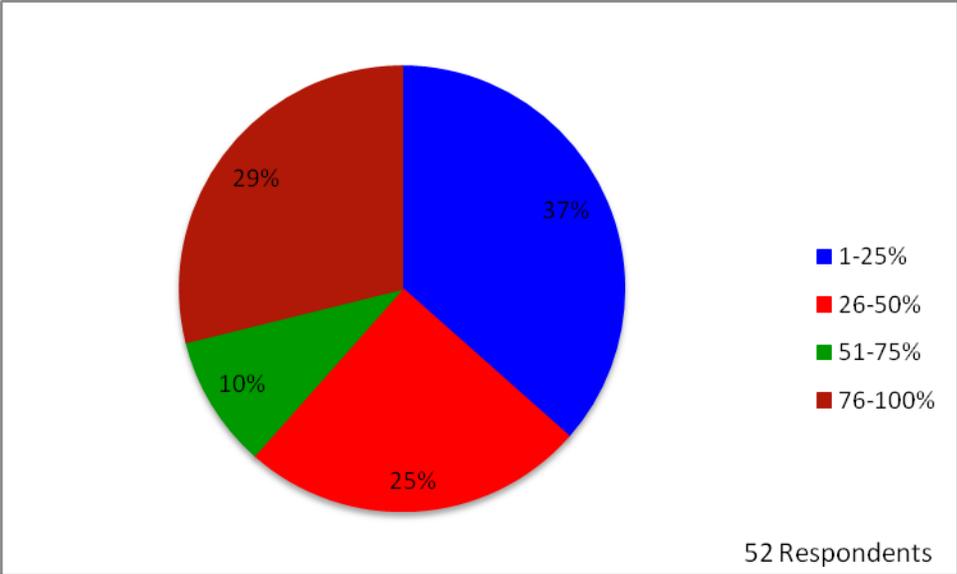


Figure 4.8 Percentage of Local Haul (less than 50 miles)

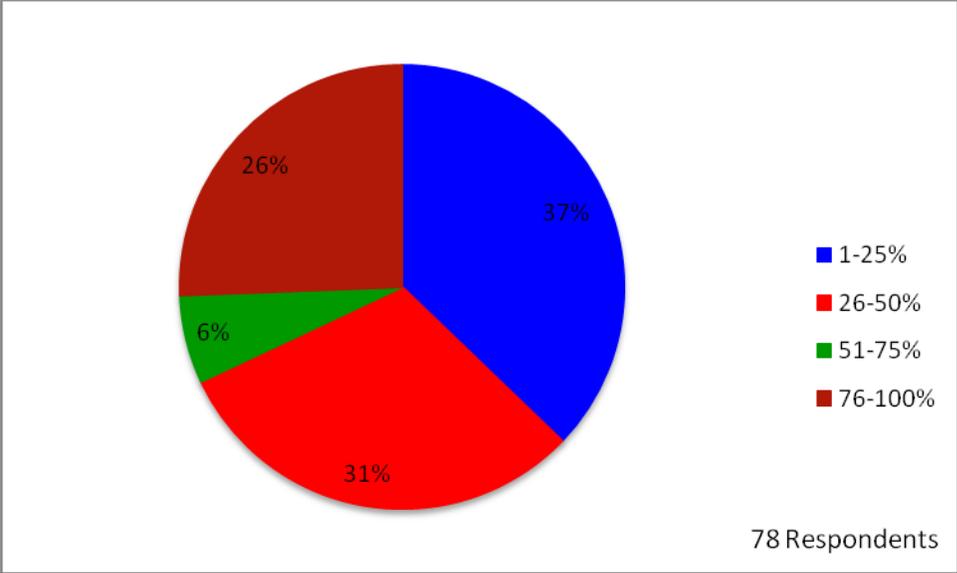


Figure 4.9 Percentage of Short Haul (50 to 200 miles)

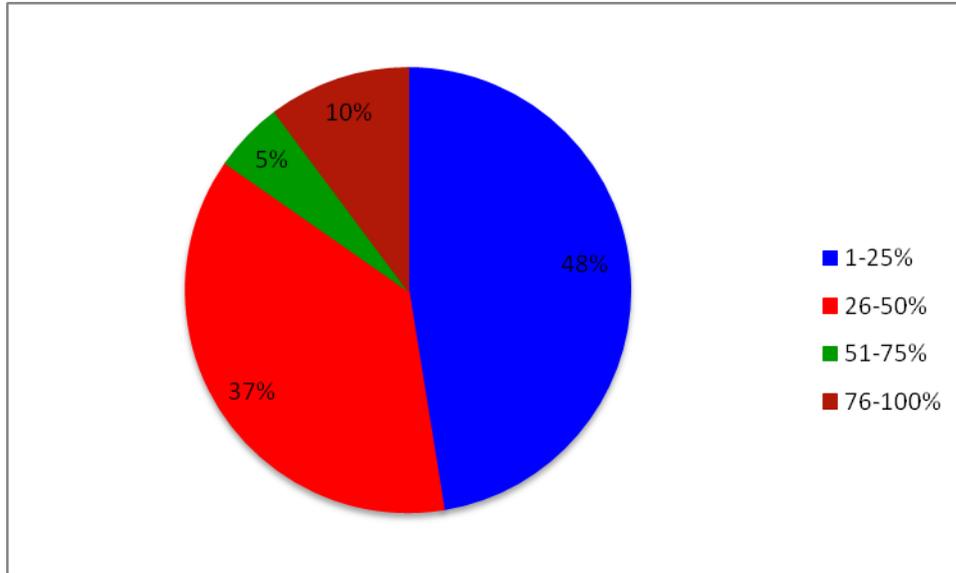


Figure 4.10 Percentage of Medium Haul (201 to 500 miles)

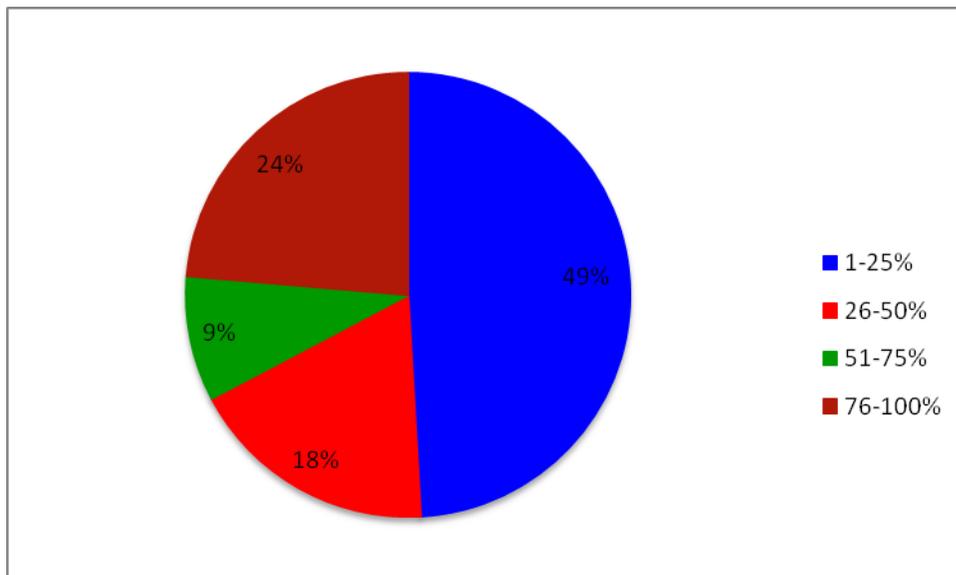


Figure 4.11 Percentage of Long Haul (more than 500 miles)

4.5.1 Operational Characteristics

When asked about their perception about road congestion in the areas they most traveled i.e. Dallas, Houston Central Texas, 63% of the respondents indicated that they consider congestion a major problem to their daily operation and 20% consider it a moderate problem (Figure 4.12). Less than 1% indicated that congestion was no problem at all.

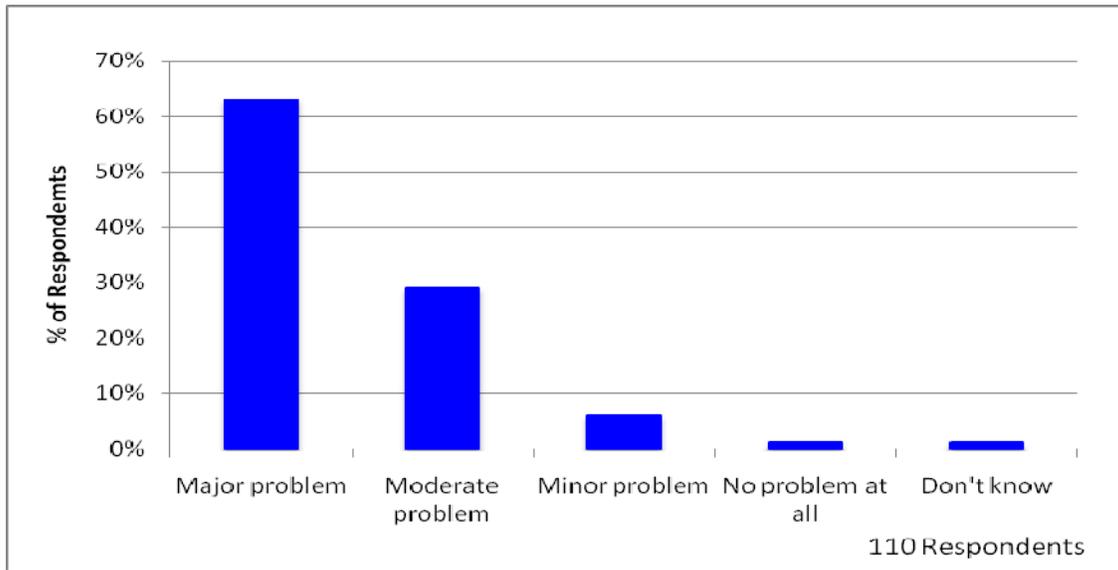


Figure 4.12 Perception of Congestion

Consequently, when asked if their operation was impacted by congestion, 81% indicated that they were in fact impacted by it. As shown in Figure 4.13, most respondents indicated that the greatest impact caused by congestion was higher fuel costs (28% of responses), slower deliveries (22% of responses), and higher labor costs (19% of responses). Many stated that congestion did not limit the number of deliveries made but that it made them slower and more costly and many times making them run late.

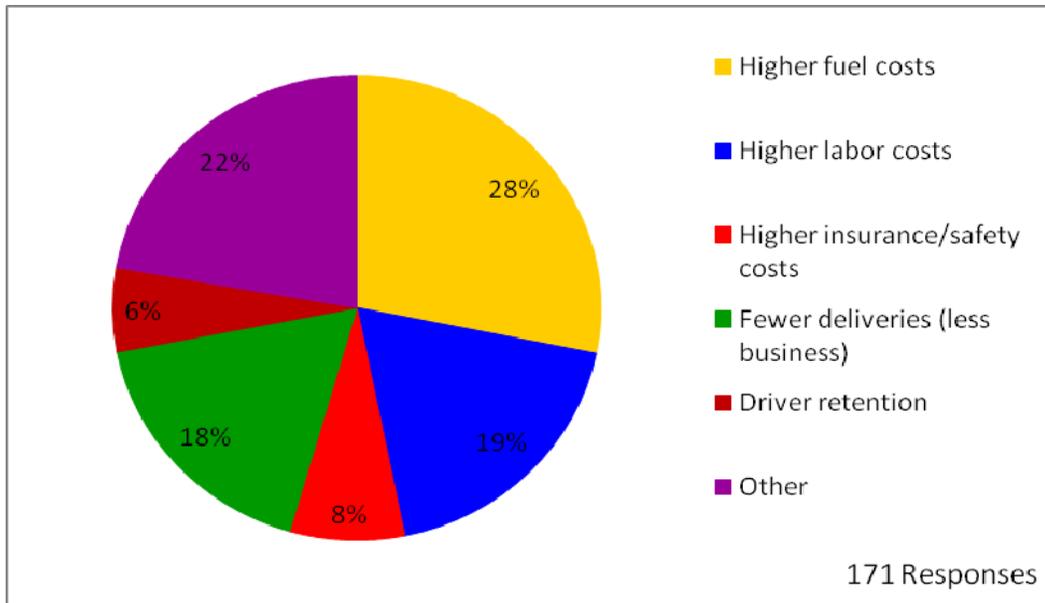


Figure 4.13 Impacts caused by Congestion impacts

For the researchers to further understand the ways in which truck carrier operations were impacted by congestion, respondents were asked questions about the type of commodity they transported, its time sensitivity, and whether they had a delivery window in which to deliver this time sensitive commodity. Figures 4.14 through 4.18 show the results of the responses for these questions.

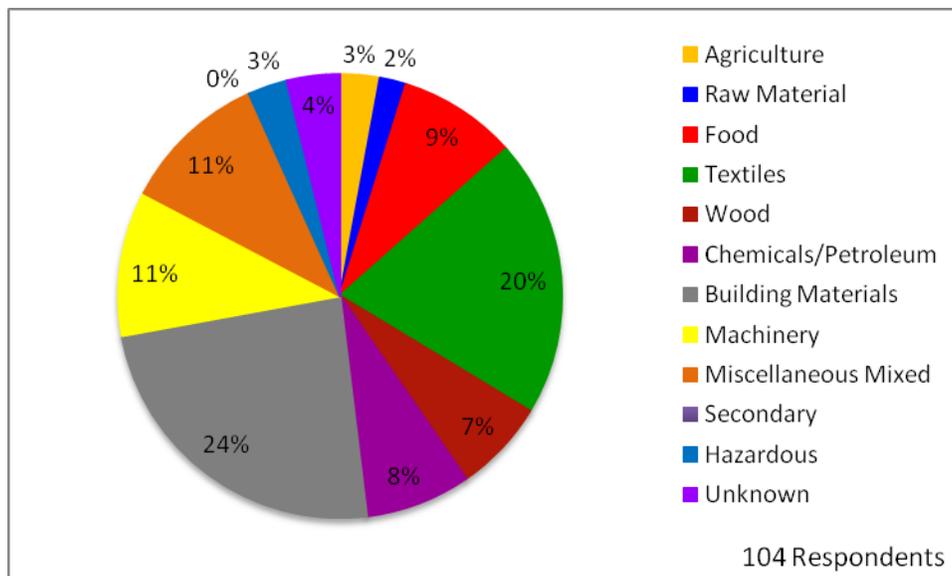


Figure 4.14 Major Commodities transported

As shown in Figure 4.15, when asked if the commodities they transported were time sensitive, 77% of the respondents answered that indeed it was and 23% of the respondents who transported time sensitive communities indicated that they had a delivery window (Figure 4.16).

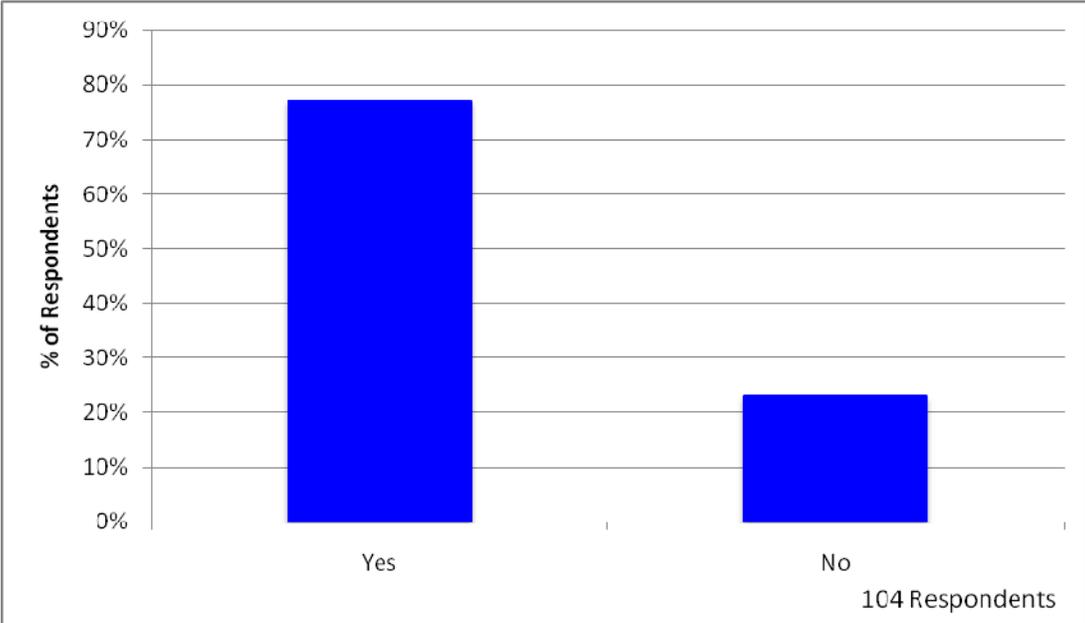


Figure 4.15 Commodity Time Sensitivity

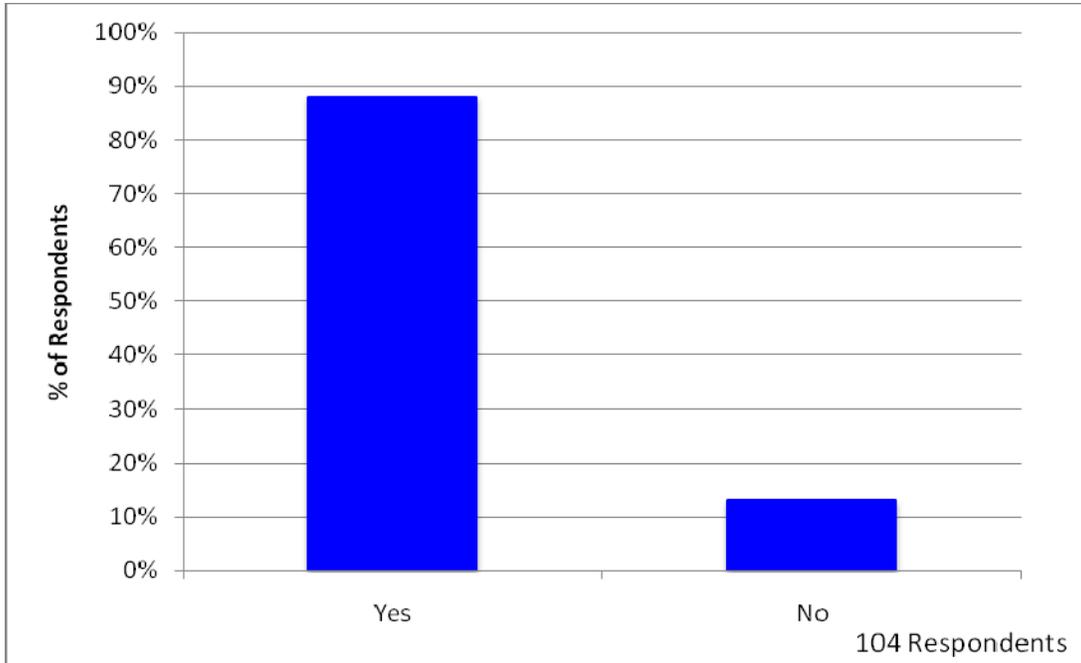


Figure 4.16 Delivery Window

Figure 4.17 illustrates the responses to this same question by operation type; the percentages shown are within each operation group. As shown in the figure, the same general trend is evident that most operations viewed their major commodities move to be time sensitive, with 100% of the respondents from the Parcel/Express sector indicating they delivered time sensitive goods within a specified delivery window. This of course is to be expected when considering the goods this sector delivers. Of all of the trucking sectors, the private carriers were the ones with the highest percentage that did not transport time sensitive commodities – i.e. 35% of private carriers did not transport time sensitive commodities.

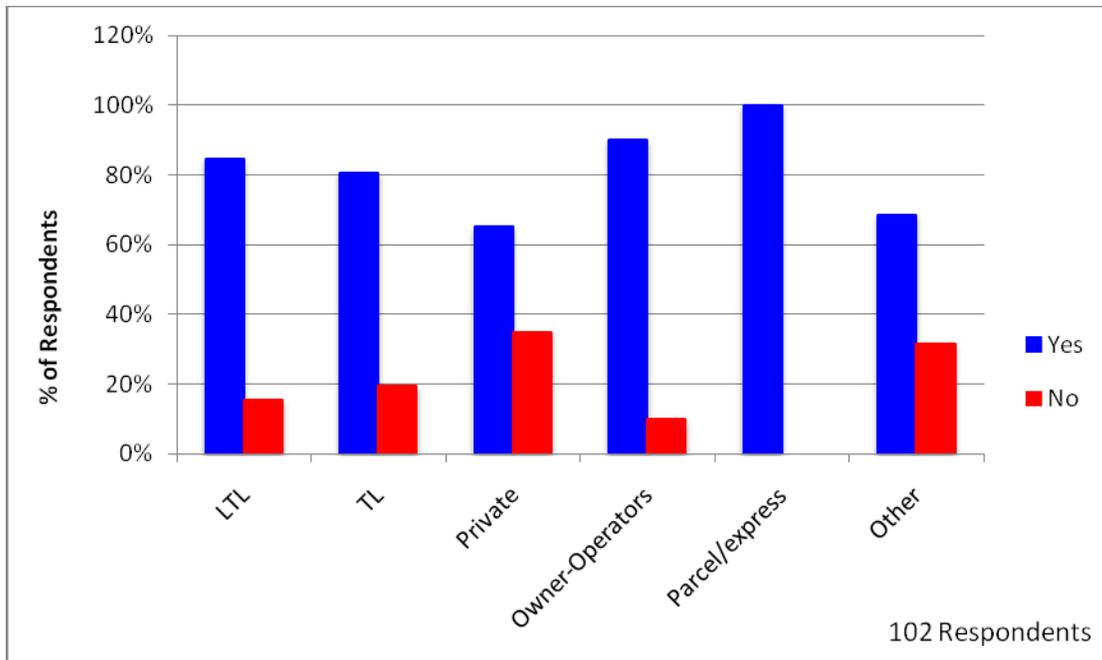


Figure 4.17 Time Sensitivity within Operational Group (by columns)

The overwhelmingly majority of respondents indicated to have a delivery window (see Figure 4.18). On average 10% of respondents by operation type indicated not to have a delivery window – the exception being parcel/express where all respondents comprising this category indicated to have a delivery window. It is interesting to notice that a slightly higher percentage of private carriers (13%) reported not to have a delivery window compared to Owner Operators (10%), LTL (8%) and TL (10%).

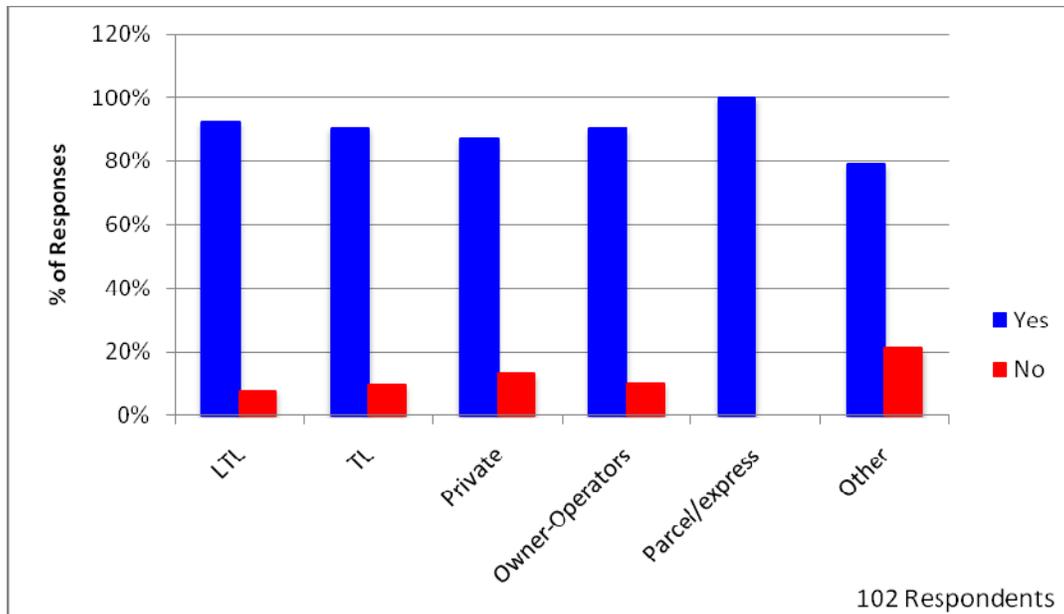


Figure 4.18 Delivery Window within Operational Group (by column)

Respondents were also asked questions regarding the range of their delivery window and the time they conducted most of their business. From Figure 4.19, it is evident that 31% indicated they had a range between one and two hours and 26% indicated a delivery range below one hour. Of those that indicated to have a delivery window of less than one hour, 6% of the respondents stated that their delivery window was less than 15 minutes.

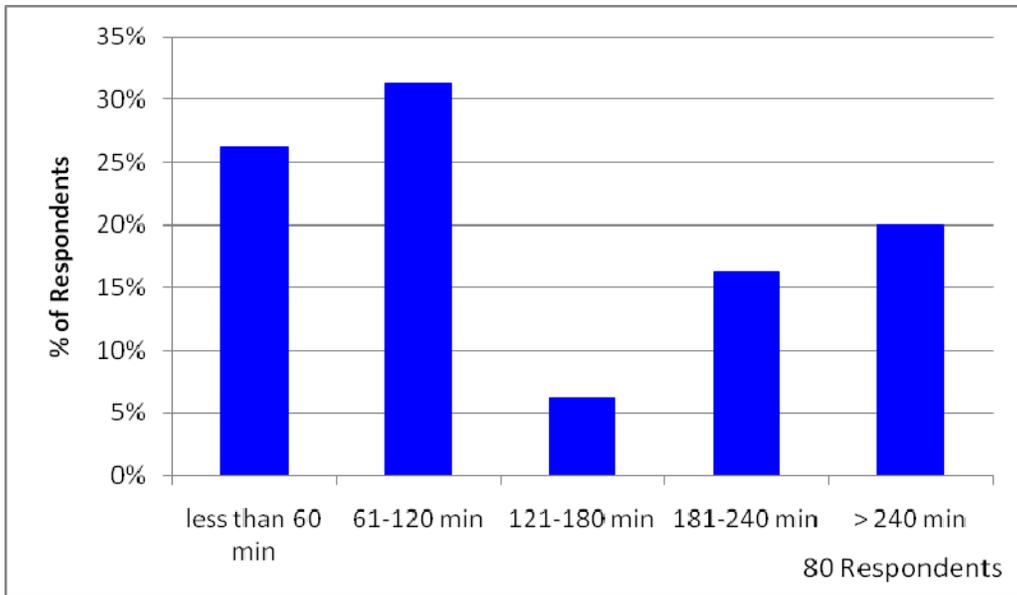


Figure 4.19 Range of Delivery Window

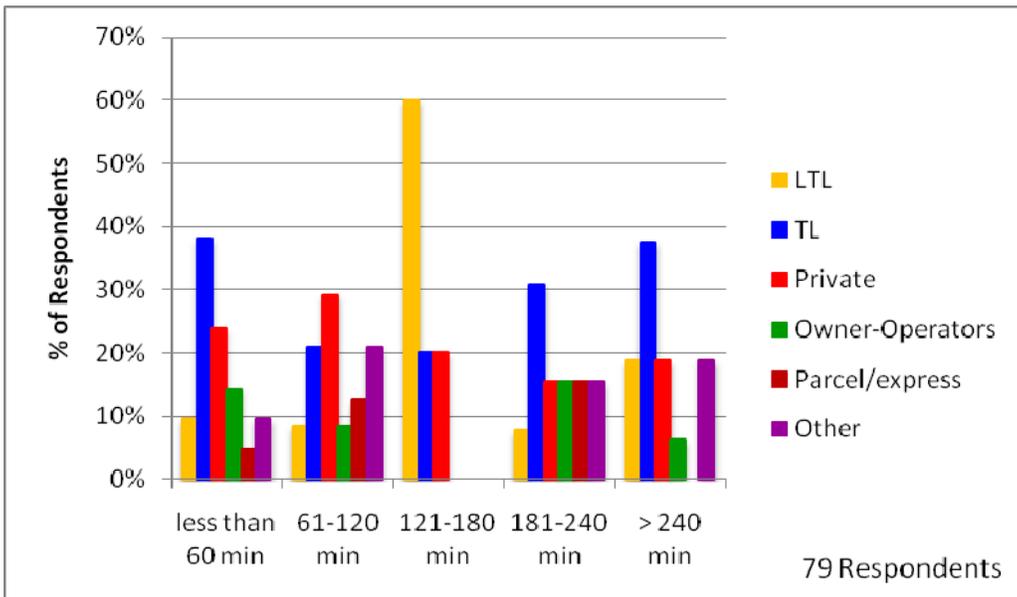


Figure 4.20 Range of Delivery Window by Type of Operation

As to the time in which they make most of their deliveries, most of the respondents (46%) stated it to be during the morning peak hours (7:01am to 9:00am) with the other most significant time frame (34% of respondents) being between 9:01am to 12:00pm. In general, most respondents indicated that they make deliveries between 7:00am and noon (80% of respondents).

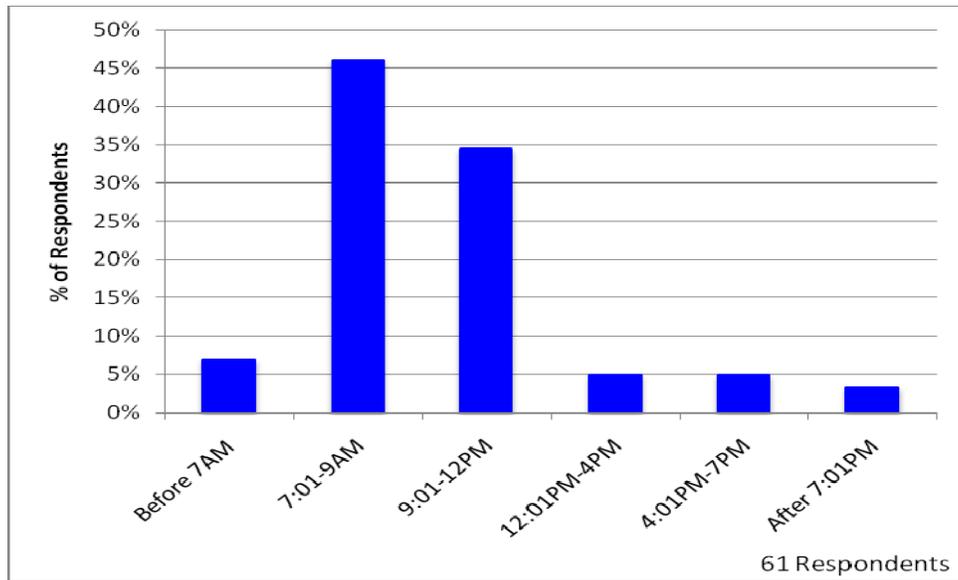


Figure 4.21 Time of Delivery

As seen in Figure 4.22, the trucking sector that seems to conduct most of their business during the morning peak hours is the TL carriers (83% of respondents). As for LTL carriers, 67% make most deliveries between 9:00am and noon. Similarly, Parcel/express carriers and the carriers that comprise the Other category make most of their deliveries within the same time frame, 60% and 53% respectively. Few respondents indicated that most of their deliveries are made after noon, with the exception of Owner Operators, in which case, 40% of respondents indicated that they make most of their deliveries after 7:00pm.

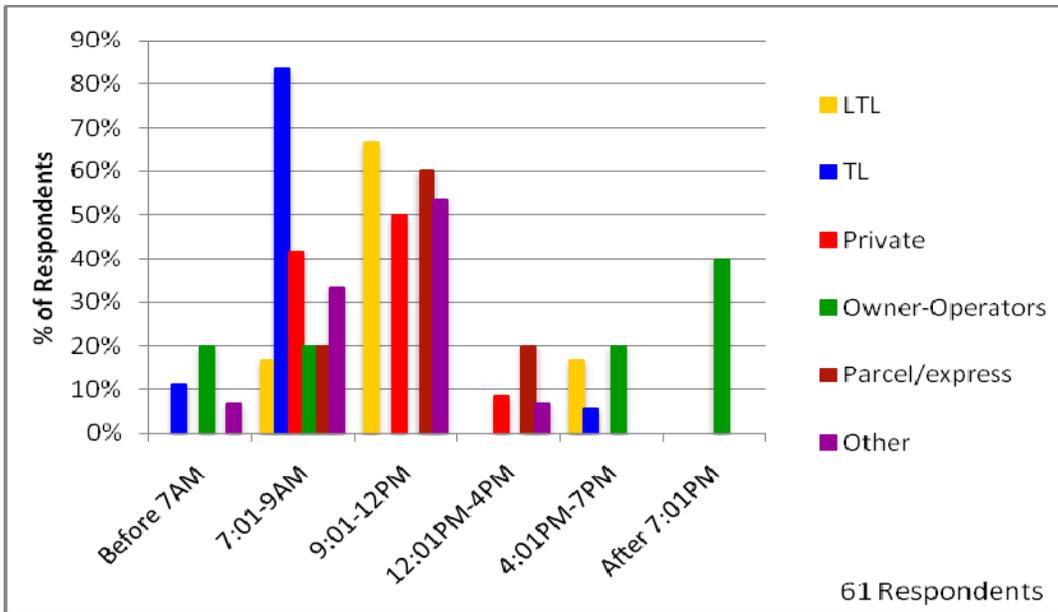


Figure 4.22 Time of Delivery – Type of Operation

Respondents were asked to provide information as to which method was used for driver compensations (e.g. per load, per mile, per hour, per stops, percentage). Figure 4.23 shows that the compensation methods most used are: per load (34% of responses), per mile (28% of responses), and per hour (27% of responses). If more than one compensation method was selected respondents were asked to state how it was determined. Most respondents indicated that it depended on the distance traveled; for local trips drivers are paid per hour, whereas for longer trips they are paid per mile. Several respondents also indicated that it depends on whether the drivers were employed by the company (paid per hour) or independent drivers (paid per load).

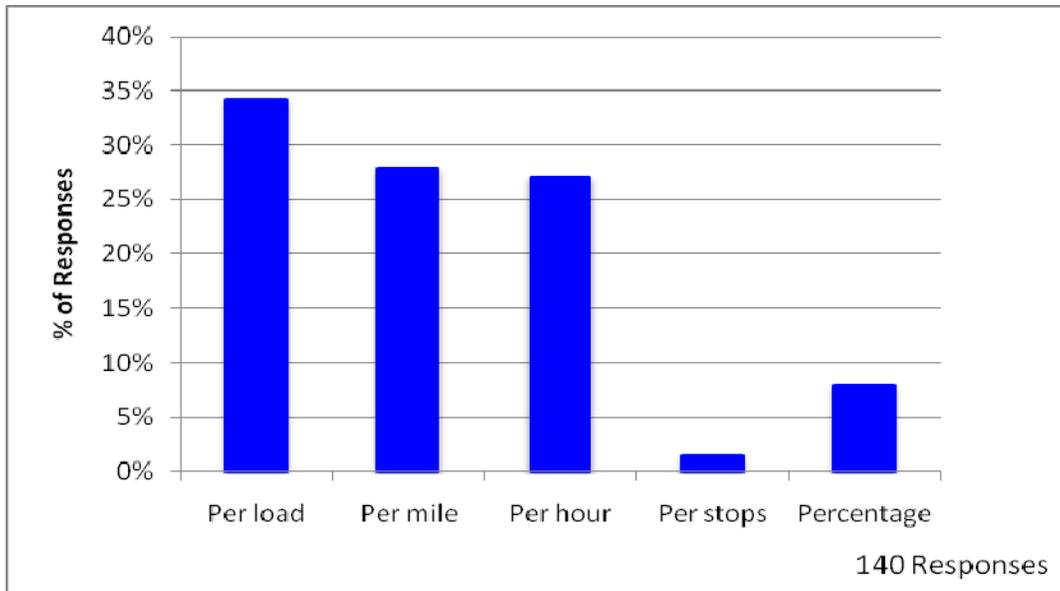


Figure 4.23 Driver compensation

In order to understand the get a better insight as to the cost structure of their operation respondents were asked to rank a series of expense categories (e.g. driver salaries and benefits, maintenance and tires, capital/depreciation, fuel, taxes, permits and licenses, insurance, and overhead). 63% of respondents ranked drivers salaries and benefits to be the most significant component, followed by fuel (57%), maintenance and tires (37%), insurance (31%), and taxes (27%). This question could not be analyzed any further since it did not receive a high response rate (43 responses out of 112).

Respondents were asked if they provided their drivers with a predetermined route. The majority of respondents (61%) indicated that they did. Looking at the different trucking sectors (Figure 4.25), a higher percentage of Parcel/express carriers indicated they did not provide their drivers with a predetermined route (71%). Similarly, 60% of Owner Operators indicated they did not provide their drivers with predetermined routes.

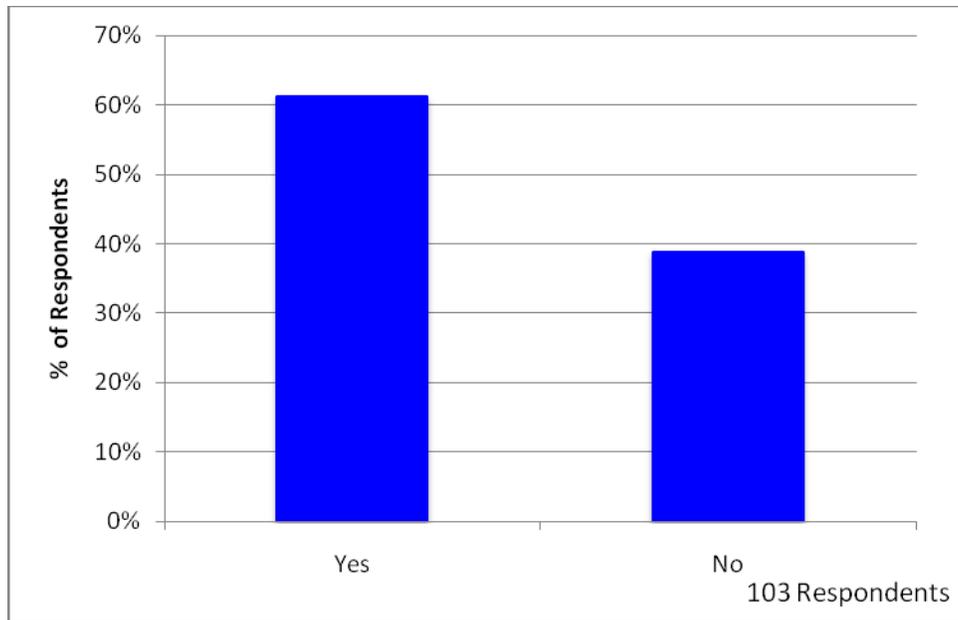


Figure 4.24 Drivers follow a Predetermined Route

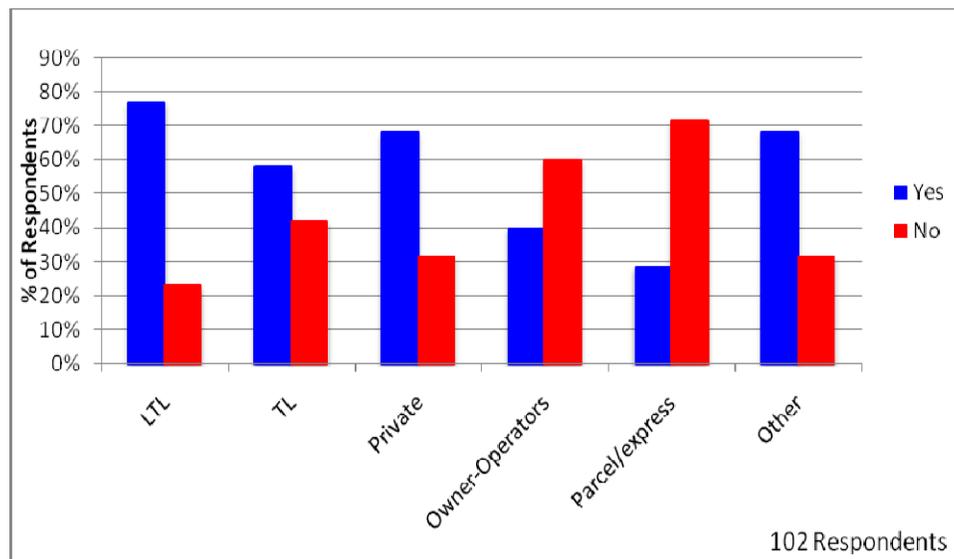


Figure 4.25 Drivers follow a Predetermined Route – Type of Operation

CHAPTER 5. CHARACTERISTICS OF THE TRUCK USERS AND NON-USERS OF TEXAS TOLL ROADS

Respondents were asked whether they use toll roads in the Dallas, Houston and Central Texas. Their response to this question allowed the researchers to classify respondents based on their actual usage or non-usage of toll roads. Different questions were asked to each group. As shown in Figure 5.1, 58% of the total respondents stated that they had used or were frequently using toll roads in the areas specified.

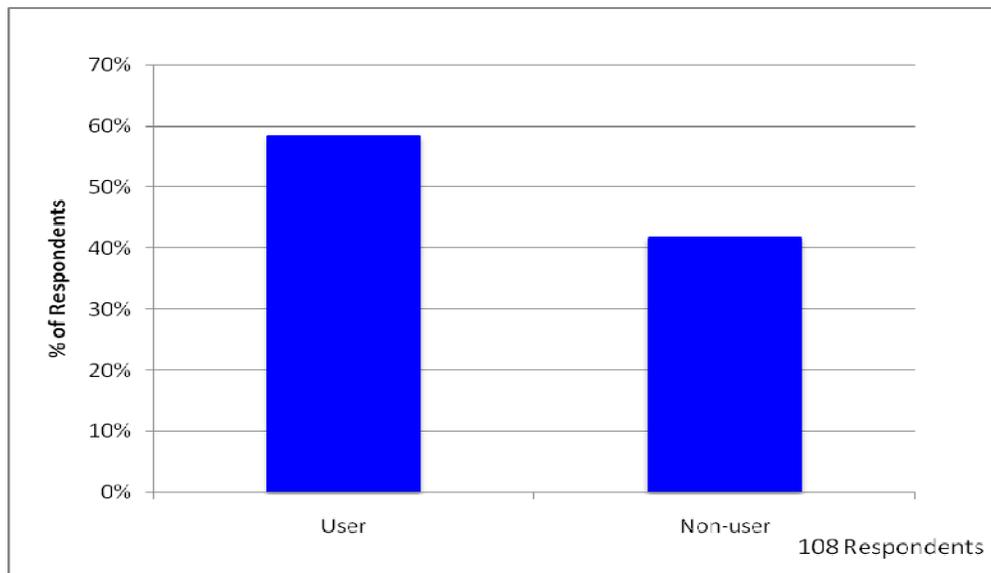


Figure 5.1 Truck Toll Usage

5.1 TRUCK TOLL ROAD USERS

Toll road users were asked questions about the benefits of toll road usage, frequency of toll road usage, the reasons for using a toll road, who made the decisions of when to use them, who was responsible for paying the toll, and their usage of electronic toll tags. The results for these responses are shown in Figures 5.2 through 5.11.

Respondents were asked what the major benefits of using toll roads are. The answers to this question were later grouped by the researchers and the results are shown in Figure 5.2. The majority of toll road users indicated time savings to be the most significant benefit they receive from using toll roads (39% of responses). Also of significance, 30% of users indicated that the

major benefit of using a toll road was because it is less congested. A slight percentage of users indicated they did not perceived any benefits from using a toll road (3% of responses).

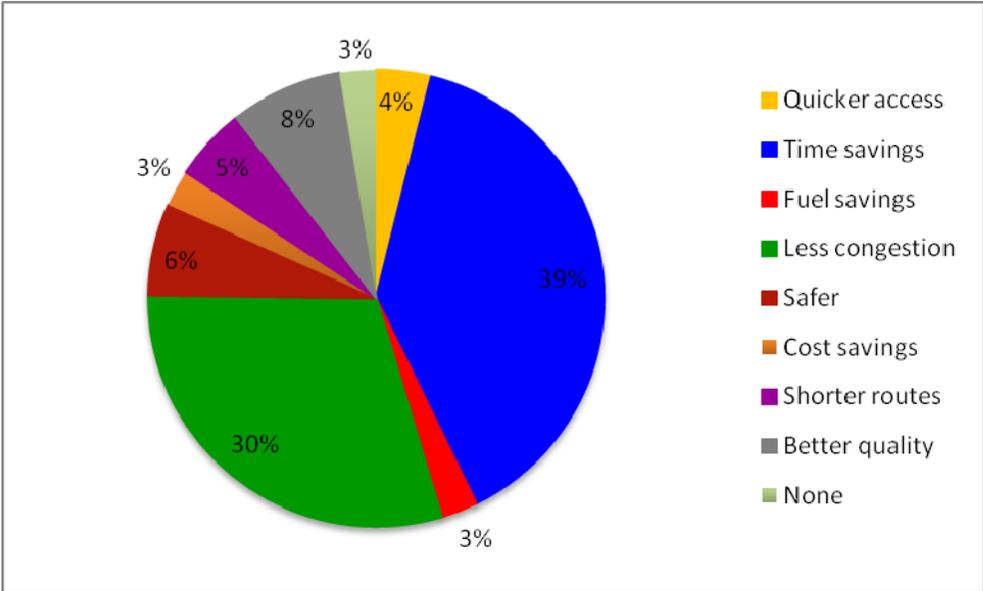


Figure 5.2 Benefits of using toll roads

Toll road users were also asked the frequency in which their drivers use toll roads. As shown in Figure 5.3, most of the respondents indicated that they used them on a daily basis (39%).

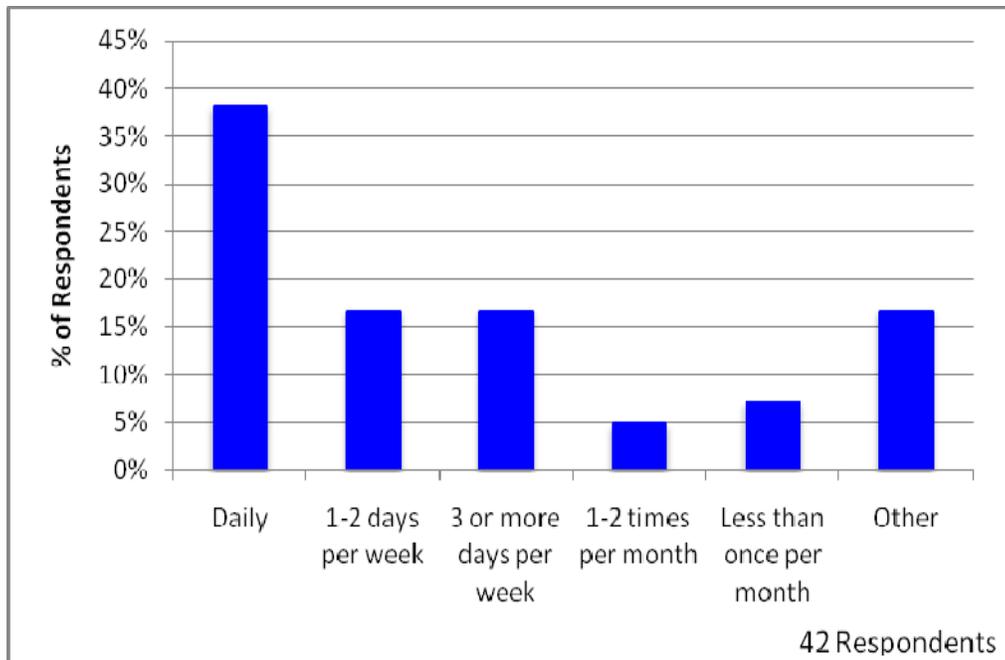


Figure 5.3 Frequency of Toll Road Usage

Of those that use toll roads daily the group that was most represented were the Parcel/Express carriers (60%). This was to be expected due to the nature of their business and their need for predictable travel times. Another group that tended to use toll roads more frequently than others was the Private carriers (55%). Since these carriers transport their own products they serve as both the carrier and the shipper making it easier for them to allocate the cost of tolls and passing it on to the customer (AECOM, 2006). Almost 30% of TL carriers use toll roads 3 or more days per week and 40% of LTL carriers use toll roads 1-2 days per week. On the other hand, 18% of TL and 17% of Other said they used toll roads less than once per month.

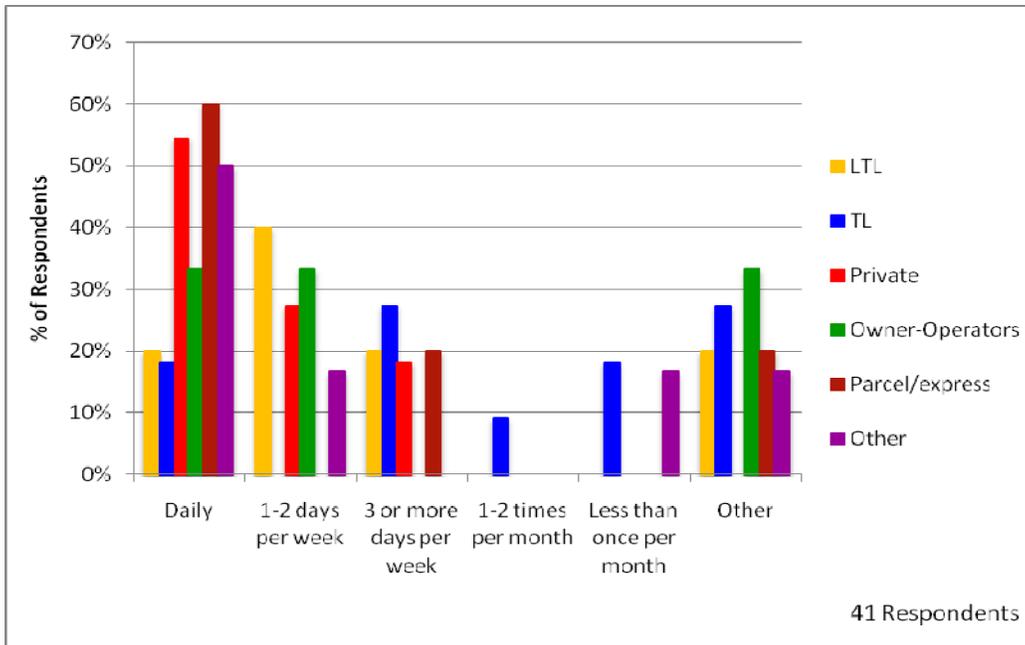


Figure 5.4 Frequency of Toll Road Usage – Type of Operation

As shown in Figure 5.5, most (84%) of the toll roads users stated that the company was responsible for paying the tolls. Only 2% responded that the customer pays for the toll roads.

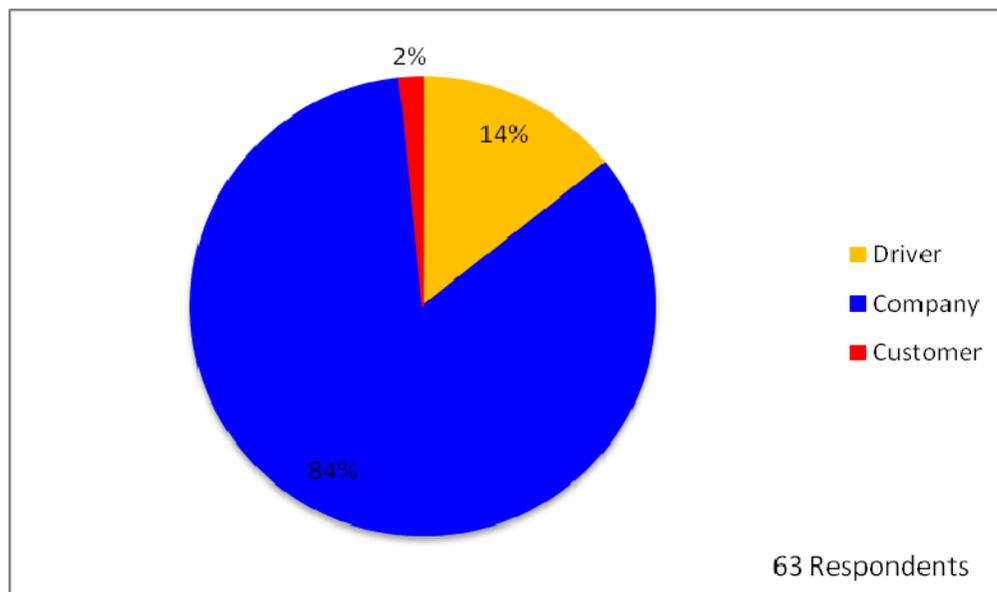


Figure 5.5 Toll Payee

Toll road users were also asked whether or not their fleets were equipped with an electronic toll tag with which to pay for tolls. Figure 5.6 illustrates that 55% of respondents stated that all their power units were equipped with an electronic toll tag.

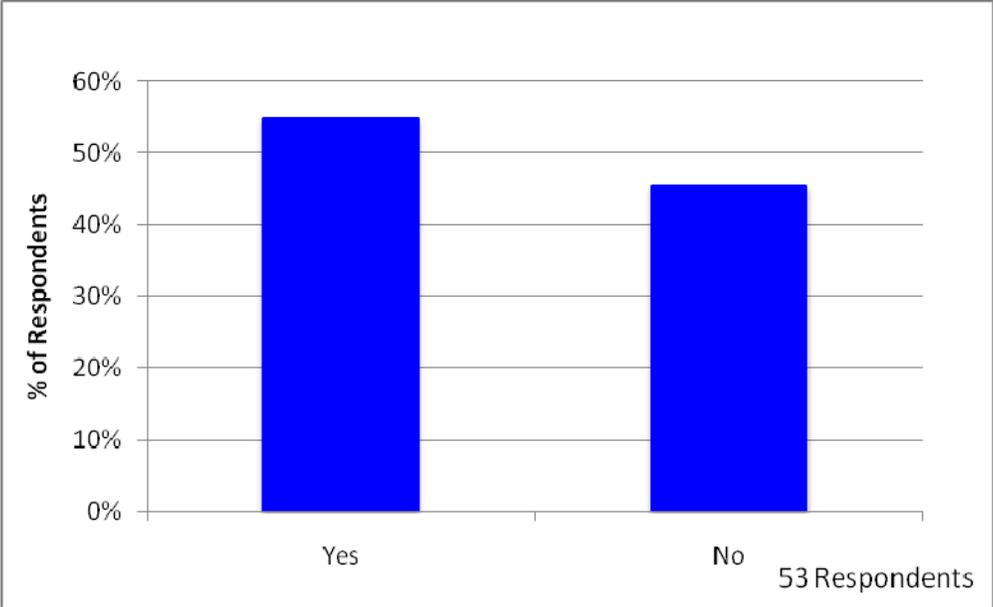


Figure 5.6 Electronic Toll Tag Usage

As shown in Figure 5.7, when asked under what circumstances their drivers were allowed to use toll roads, most toll road users indicated that they were allowed to use them all the time (33% of responses). Also significant, 25% indicated that it was up to the driver’s discretion whether or not to use a toll road and 20% indicate that it depended on where the delivery was located.

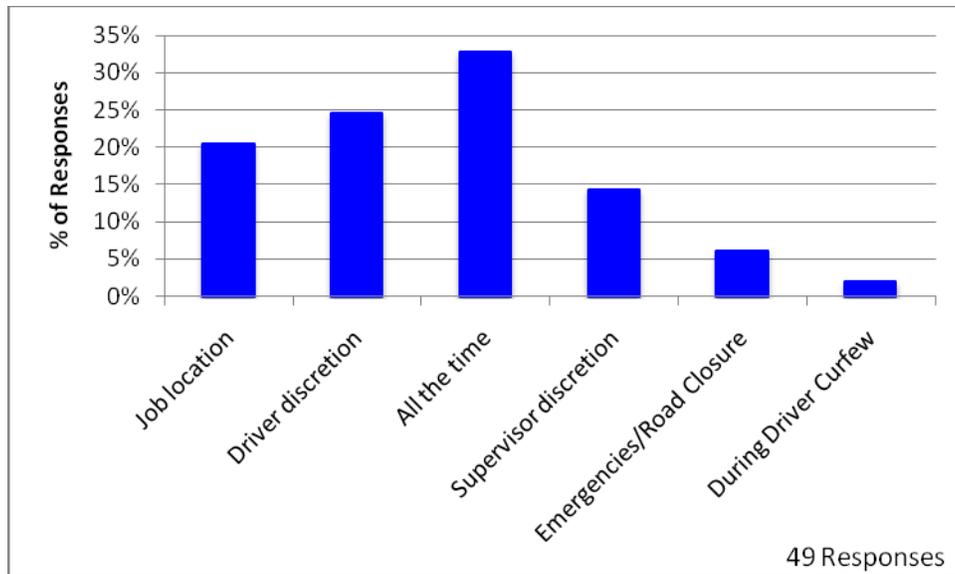


Figure 5.7 When is toll road usage allowed?

Looking at this same question but within type of operation (Figure 5.8), Owner-Operators tended to state that the decision was up to the drivers discretion (75%). This is to be expected since many drivers own the truck that they were driving. Also this type of carriers usually does not provide drivers with predetermined routes, as was previously discussed. 43% of LTL respondents reported that drivers are allowed to use toll roads all the time. More than 60% of TL respondents reported that drivers are allowed to use toll roads either all the time or at driver discretion. Something interesting to notice is the fact that 33% of Parcel/express respondents indicated that drivers can use toll roads only at a supervisor's discretion. This does not match with the fact that 71% of this group does not provide their drivers with predetermined routes. (Section 4.5)

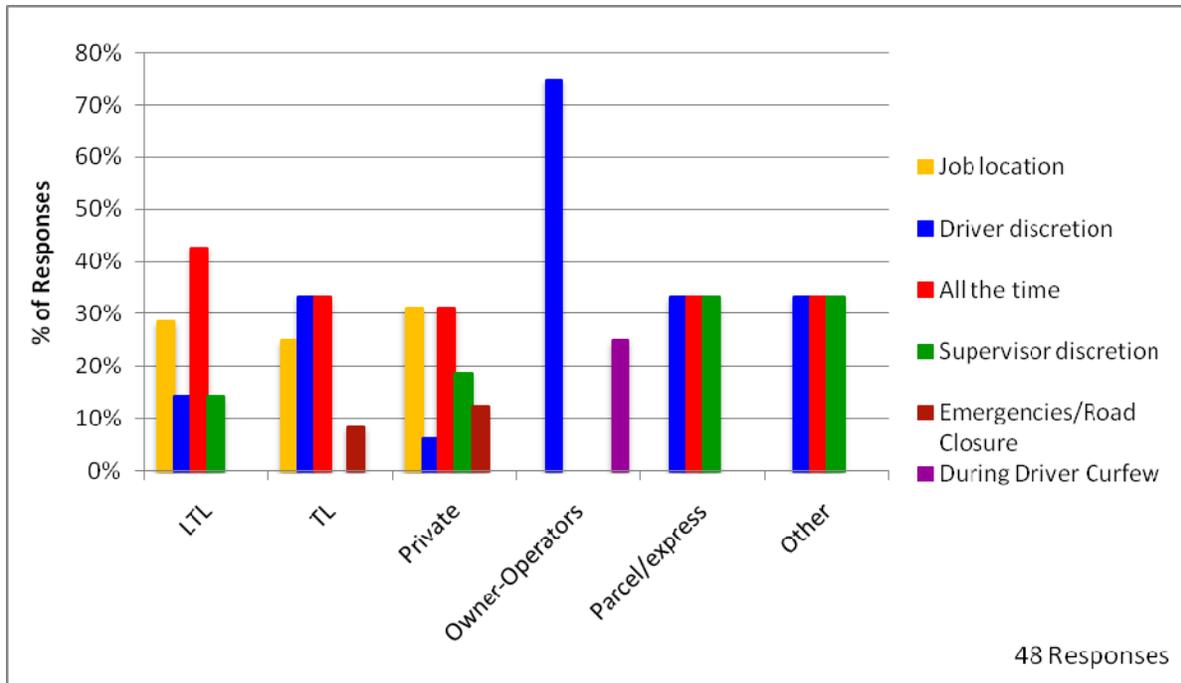


Figure 5.8 When is toll road usage allowed - Type of Operation

Of those that stated that the company paid for the toll, 35% of them were Private carriers, 24% TL carriers and 16% LTL carriers, as seen in Figure 5.9. Of those that stated that the driver was responsible for paying for the toll, almost 45% were TL carriers, as seen in Figure 5.10.

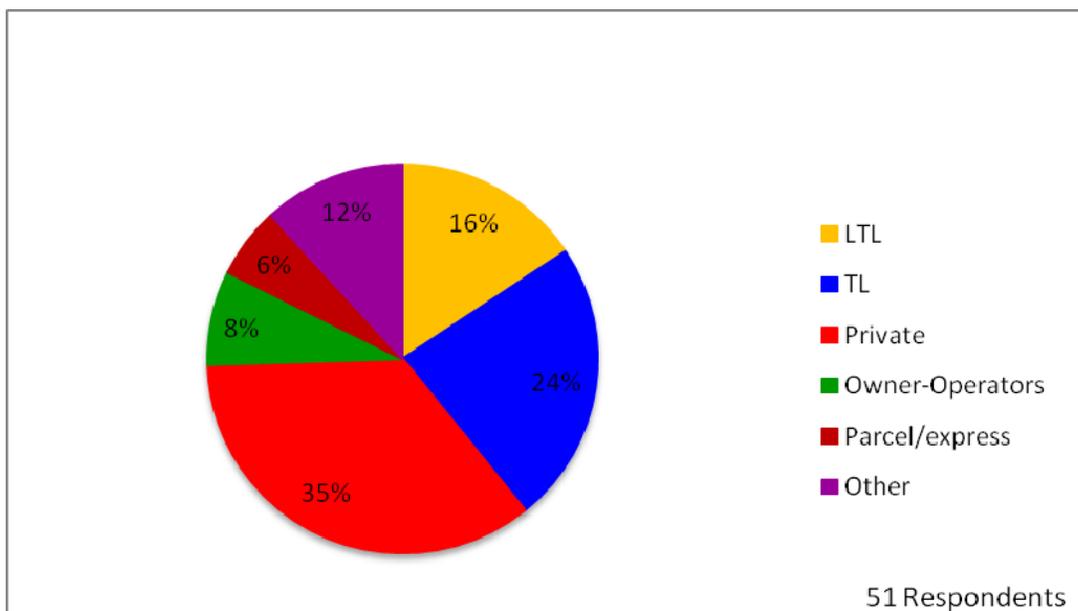


Figure 5.9 Company Pays for Toll Road Usage - Type of Operation

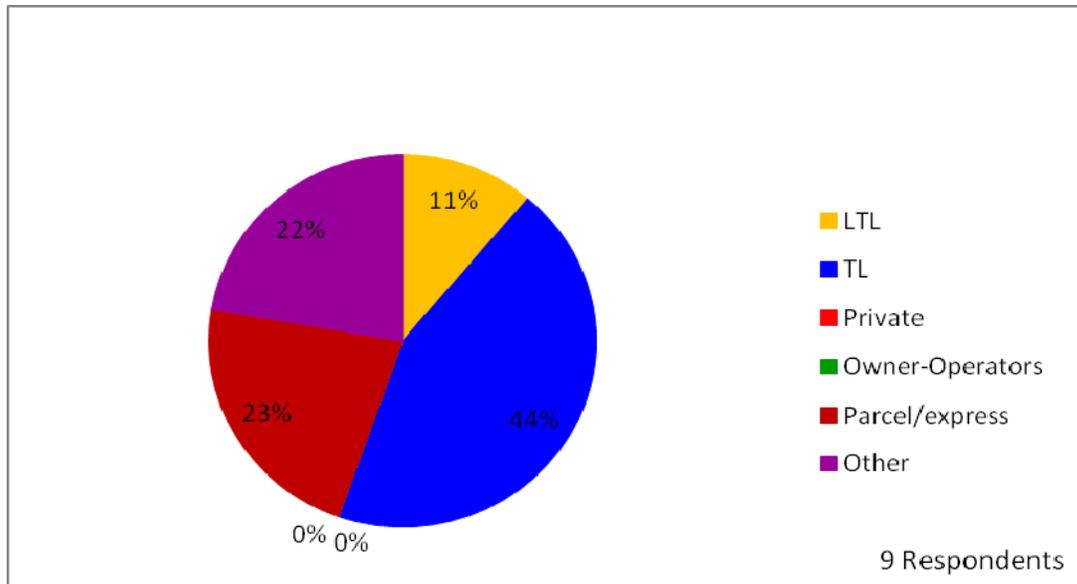


Figure 5.10 Driver Pays for Toll Usage – Type of Operation

Respondents who indicated that the drivers were required to pay the toll were subsequently asked whether their company be willing to pay for the toll if it provided them with perceived benefits such as travel time savings, higher speed limits, higher weight limits, separate lanes for trucks, avoidance to congestion. To those that answered that they would use a toll road if it offered travel time savings were asked how much time was needed to be saved and how much they were willing to pay for that time saving. Due to a low response rate for these question the sample size was too small (3 responses) making the data unreliable for any statistical analysis.

From Figure 5.11 it is evident that 100% of the Parcel/express respondents indicated that their power units were equipped with an electronic toll tag. Similarly for private carriers and LTL carriers, in which 78% and 63% respectively, stated that their fleets were equipped with electronic toll tags. On the other hand, 92% of the TL carriers respondents indicated that their power units were not equipped with an electronic toll tag were TL carriers. Owner Operators and Other carriers are divided by 50% that did have electronic toll tags on their fleets and 50% that did not.

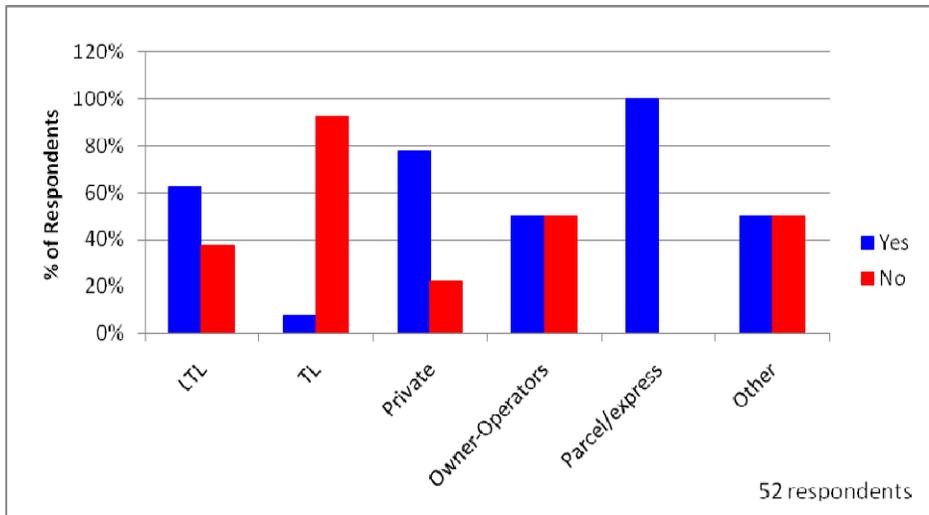


Figure 5.11 Electronic Toll Tag Users by Type of Operation- (by rows)

5.2 TRUCK NON-TOLL ROAD USERS

Respondents that stated that they had never used a toll road were asked questions regarding the reasons for their non-usage, and the conditions under which they would most likely decide to use and be willing to pay for a toll road. As shown in Figure 5.12, the most significant reasons of why non-toll road users do not use toll roads are because there are no toll roads in their business area (35% of respondents) and because the cost of using toll roads is too high (35% of respondents).

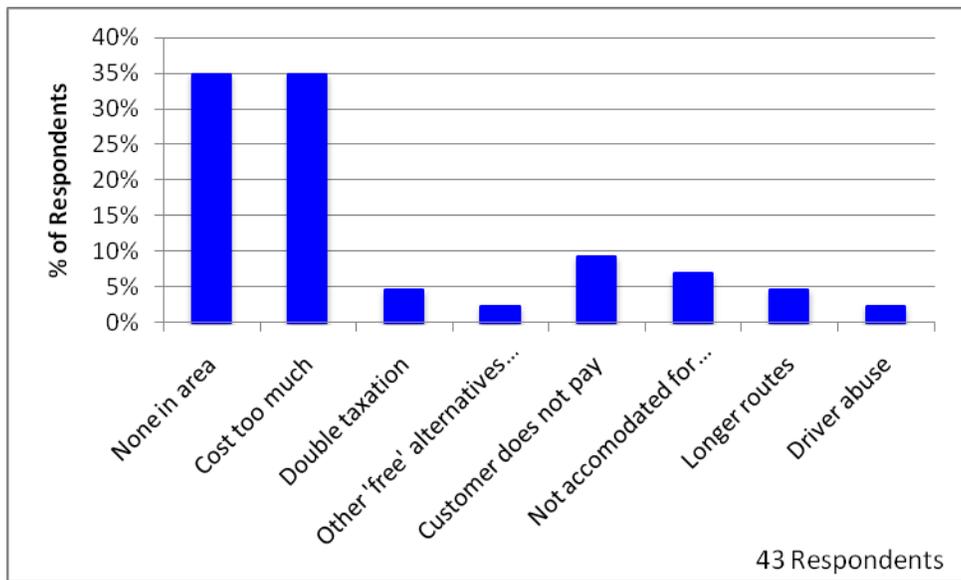


Figure 5.12 Reasons for Not Using Toll Roads

As seen in Figure 5.13, these reasons vary greatly from one sector to another. 50% of LTL respondent did not use a toll road because none was available in the area, 25% felt it cost too much, and another 25% indicated that the customer does not cover the costs of the toll as their reason for not using toll roads. Similarly, 40% of the Owner-Operator respondents did not use a toll road because none was in the area, 40% felt it cost too much, and 20% indicated that it was double taxation. It is interesting to notice that none of the private carrier respondents indicated that toll roads cost too much as a reason for not using them. Finally the Parcel/express respondents were divided: half of the respondents reported not to use toll roads because of costs and the other half did not use a toll road because none were available.

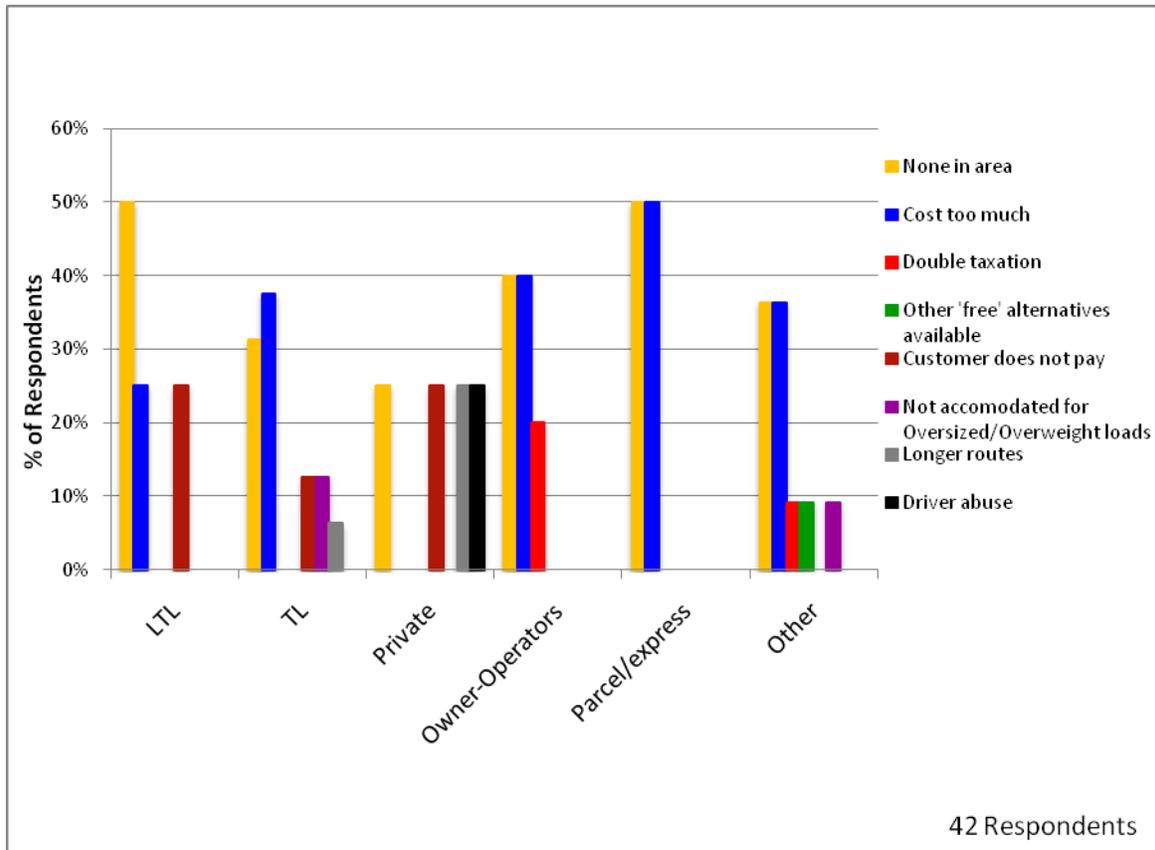


Figure 5.13 Reasons for Not Using Toll Roads – Type of Operation

As seen in Figure 5.14, When asked about their willingness to pay for the usage of a toll road most respondents (32%) answered that they would never use them. This reiterates what was

mentioned previously that non-users tend to express an anti-toll sentiment and are not willing to respond positively to anything that has to do with toll roads.

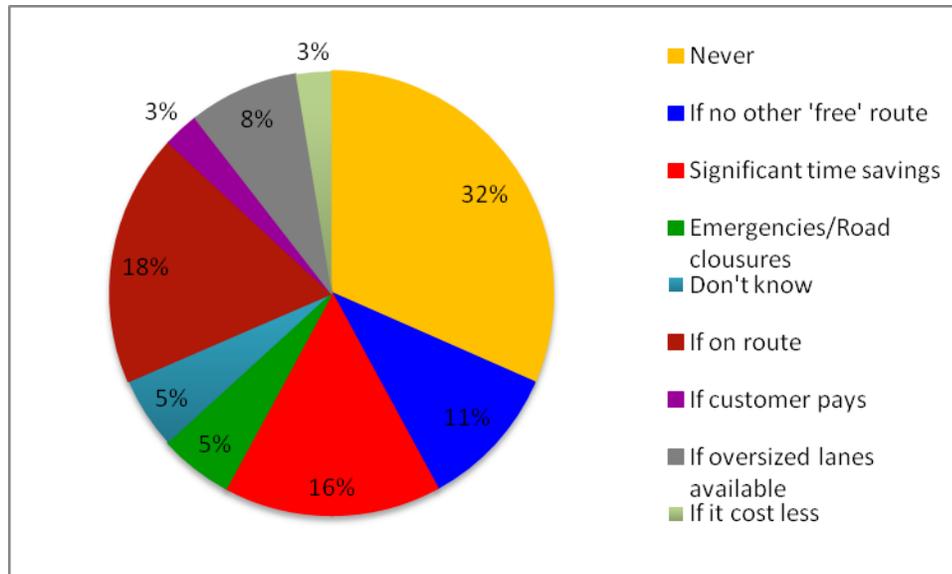


Figure 5.14 Non-Users Willingness to Use Toll Roads

Looking at the same question within each sector, 100% of the Parcel/express respondents indicated that they would never use a toll road, as seen in Figure 5.15. Also almost 70% of the private carrier respondents indicated that they would never use a toll road. On the other hand almost 50% of the LTL respondents indicated that they would use a toll road if significant time savings would be achieved. The only sector that responded that they would be willing to use a toll road if the customer paid for it was the Other group (10% of respondents). From additional comments obtained for this question, the researchers noted that many of the respondents do not see the customer paying the toll as an option to use it, many of them express that the customer will never be willing to pay for the toll.

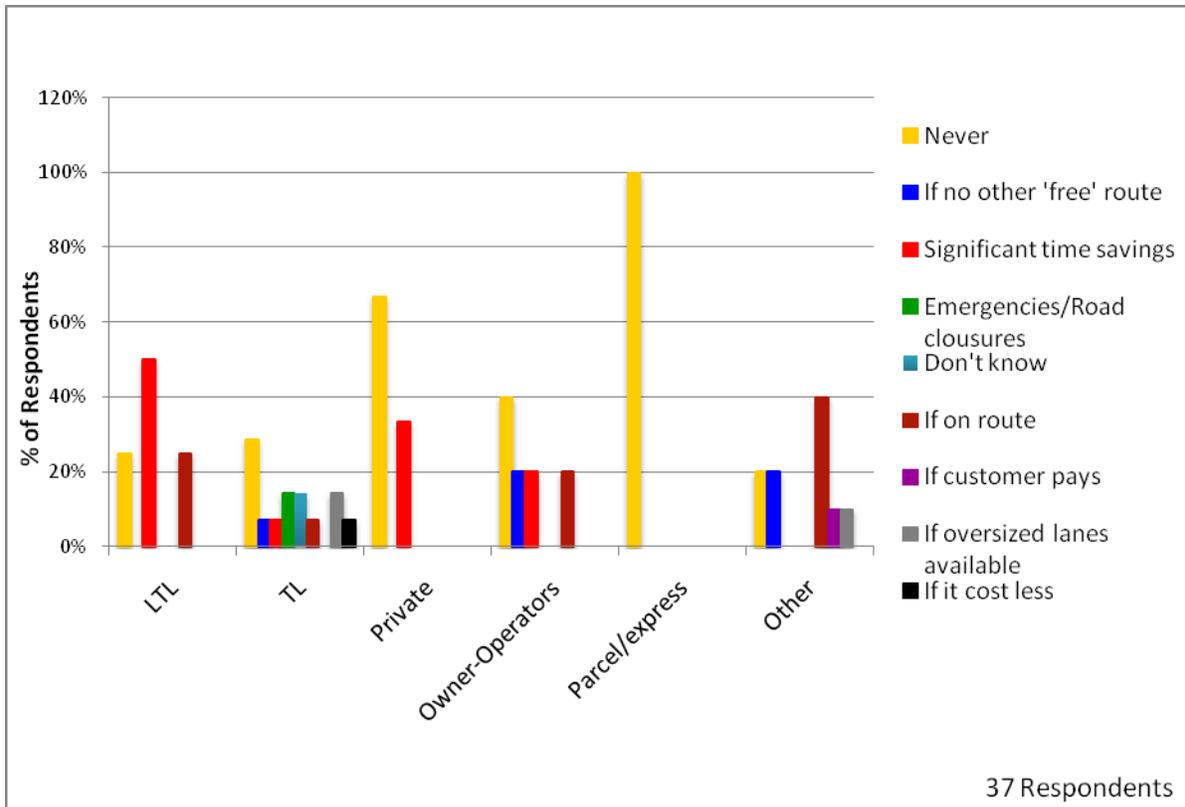


Figure 5.15 Non-Users Willingness to Use Toll Roads - Type of Operation

Non-users were asked whether their company would be willing to pay for a toll if it provided them with perceived benefits such as travel time savings, higher speed limits, higher weight limits, separate lanes for trucks, avoidance to congestion. From Figure 5.16 we can see that the most respondents are willing to pay for a toll to avoid congestion (36% of responses) or with significant time savings (29% of responses).

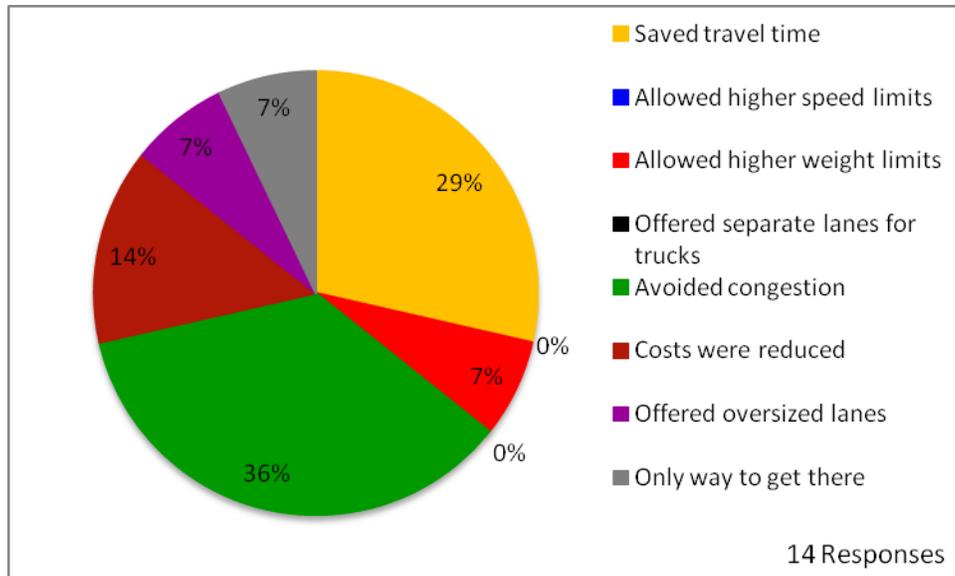


Figure 5.16 Non-Users Willingness to Pay

Those that answered that they would use a toll road if it offered travel time savings were asked how much time was needed to be saved and how much they were willing to pay for that time saving. Due to a low response rate for these question the sample size was too small (4 responses) making the data unreliable for any statistical analysis.

Finally, non-users were presented with a list of incentives to determine what will persuade them to use toll roads. Figures 5.17 demonstrate the results obtain from the respondents. When asked if they would be willing to use a toll road if they could subscribe to a toll road use plan where they could pay a discounted, fixed monthly fee for a specified amount of usage (similar to a cell phone plan), 64% of the non-users indicated that they would not, with the rest of the respondents indicating that they maybe be willing to use it.

Another incentive that was offered was the availability of frequent user discounts, such as free toll road days, free weekends or discounted toll rates. To this incentive, 52% stated that they would not be interested, 44% that they maybe be interested and only 4% that answered favorably.

The third incentive given was to extend the usage of the toll tag to be available for drivers to make other purchases such as fuel, parking of food. An overwhelming 84% answered negatively

to this incentive with no single answer in favor of it. The next incentive presented was a discount on toll rates during off-peak hours. 59% of non-users indicated that they would not be interested in such incentive and 38% indicated that they may be interested; only 3% were in favor.

Another incentive presented was whether they would be willing to use a toll road if these provided larger, well maintained truck stops with dining and truck repair facilities as well as, in-cab auxiliary power systems (such as IdleAire) alongside the toll road. Again, most respondents answered negatively (52%), only 6% were in favor of this incentive. Even when presented with a fuel tax refund for the miles traveled on the toll roads, only 9% of the non-users were willing to use them and the rest of the respondents divided between 50% not willing to use it and 41% maybe willing to use it. The last incentive option was to allow for the usage of Longer Combination Vehicles (LCV) on the toll roads. To this incentive 61% of the respondents indicated a non-interest, while 32% indicated that they may be interested.

Further analysis of the data showed some discontinuities between the trucking sectors. For example, the number of TL carriers stated that they would maybe use a toll road when given a tax fuel refund for the miles traveled on the road was the same number that said that they would not use it.

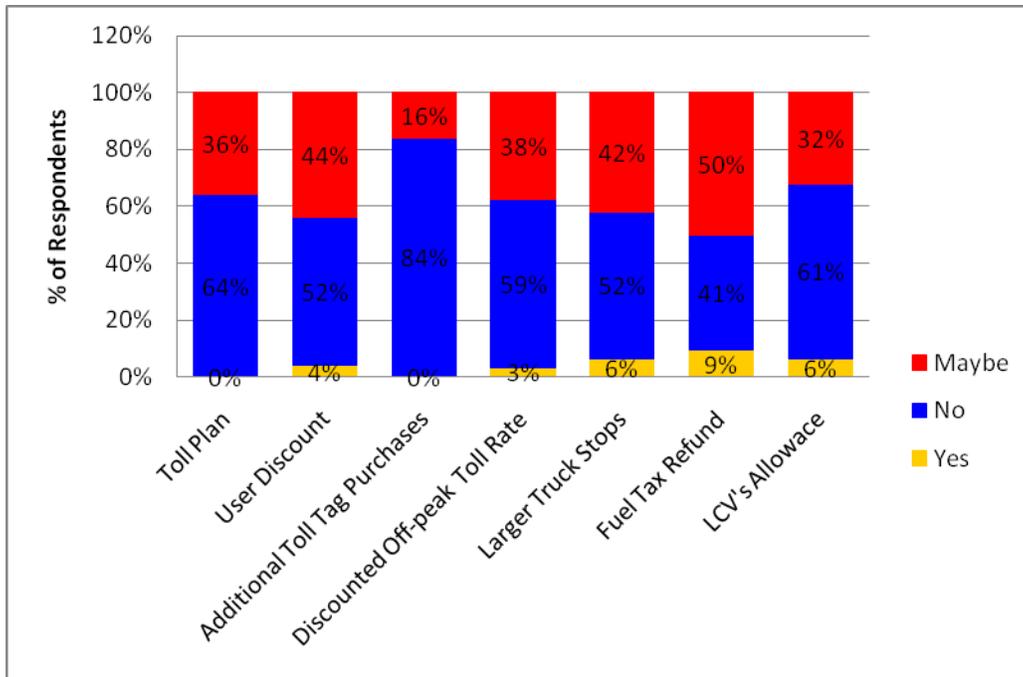


Figure 5.17 Toll Road User Incentives

Although none of the incentives seem to persuade the majority of non-toll road respondents to use toll roads, it did seem that a fuel tax refund (9% of respondents), the allowance of LCVs (6%), larger truck stops (6%) and a frequent user discount (4% of respondents) would result in a small percentage of truck users diverting to toll roads. Incentives that may result in respondents diverting to toll roads include: fuel tax refund (50% of the respondents may be using the toll road), user discounts (44%) and larger truck stops (42%). On the other hand, the least persuasive incentives are: the toll plan (64% of the respondents would not use a toll road if they could subscribe to a toll road use plan), if the toll tag could be used for other purchases (84%), and if allowed LCVs (61%).

5.3 DIFFERENCE BETWEEN TRUCK TOLL ROAD USERS AND NON-USERS

In order to look for trends amongst toll road users and non-users, comparisons between these two groups were made for several of the survey questions. Figure 5.18 illustrates the samples users and non-users were distributed amongst the different trucking sectors. In this figure we can see that the respondents belonging to the Private carrier group indicated a greater usage of toll roads (30% of the total users) than any other group. Similarly, 28% of TL carriers, 15% of LTL

carriers and 8% of Parcel/express carriers are toll road users. On the other hand, 36% of the total users of the TL carriers indicated that they were not using toll roads.

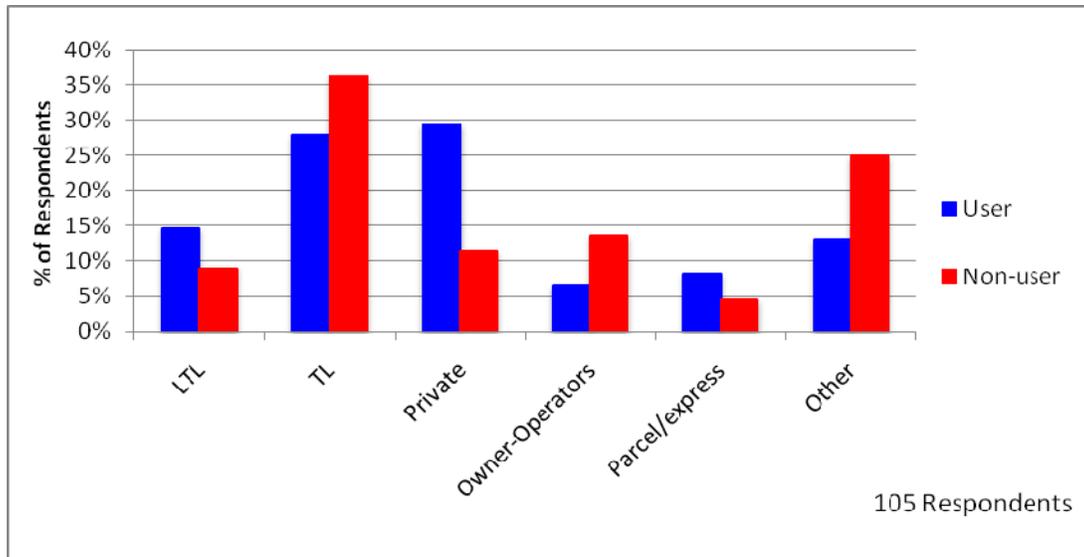


Figure 5.18 Users of Toll Roads by Type of Operation

Looking at the percentage of users within each group (Figure 5.19) we can observe that 78% of private carrier respondents, 69% of LTL carrier respondents and 71% of Parcel/express respondents are toll road users. On the other hand, 60% of Owner Operators, 58% of Other carriers and 48% of TL carriers are non-toll road users.

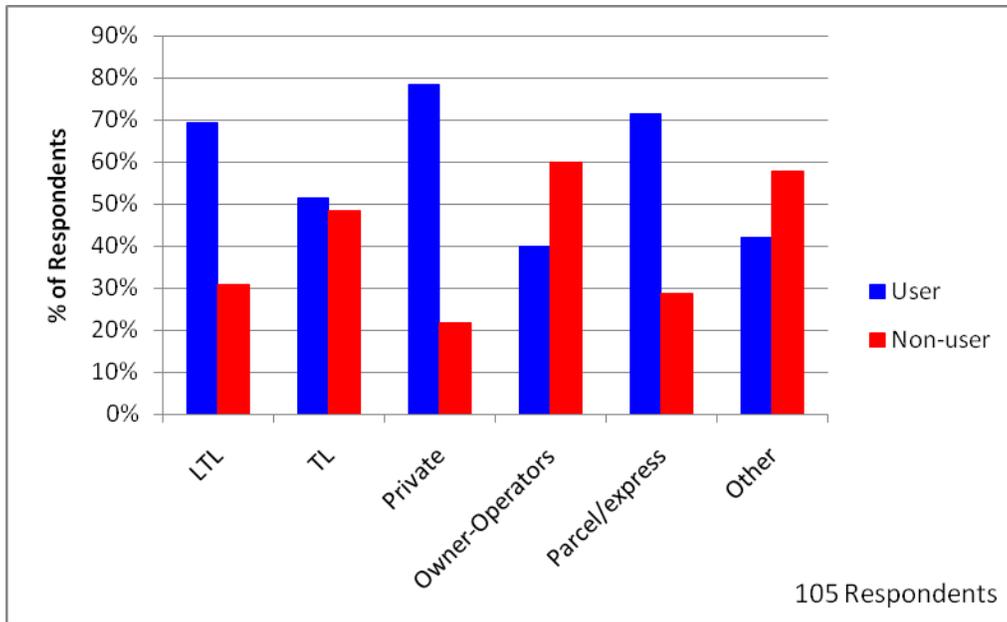


Figure 5.19 Users of Toll Roads within Operation Group (by rows)

When comparing the answers of the truck users and non-users as to their perception of congestion, the researchers noted that those respondents that answered that they did not see congestion as a problem were all (100%) non-users (Figure 5.20). This was to be expected since toll roads are seen as a way in which to mitigate congestion and if their operation is not at all impacted by it there is no need for them to shift from the ‘free’ road. Of those that thought congestion as a major problem, 63% were toll road users. The 37% that indicated congestion was a major problem, but did not use a toll road claimed that toll roads are too expensive (33%) or that there were no toll roads in the area (33%). Also of interest, 54% of those that responded that congestion was a minor problem used toll roads. The reasons provided by these respondents were because they provide time savings, is the shortest route to where they want to go and offers a better quality of travel.

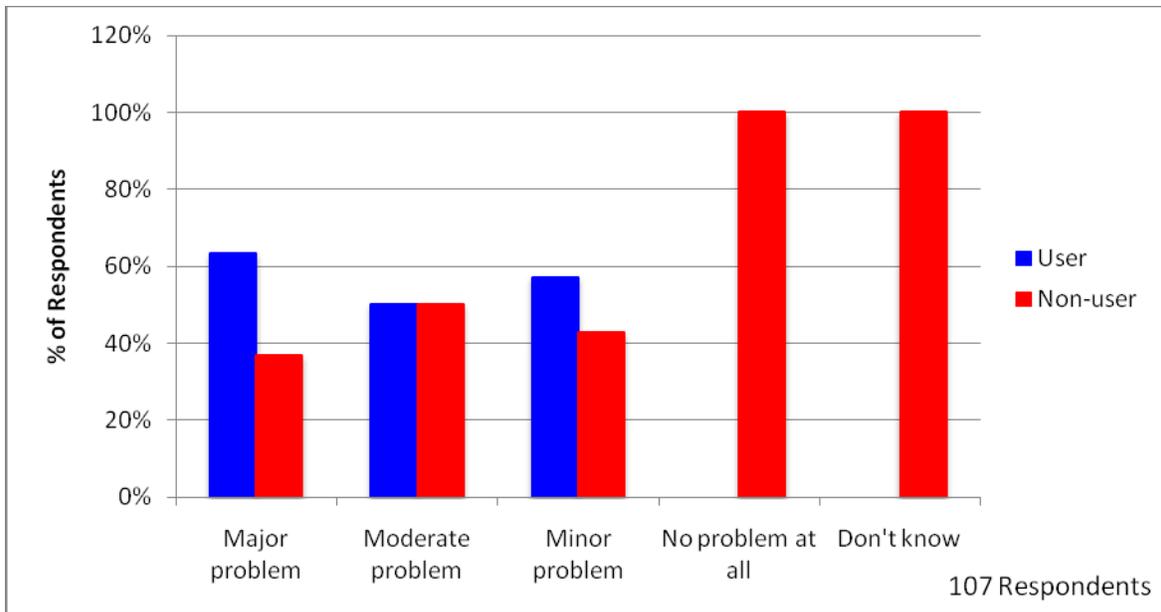


Figure 5.20 Perception of Congestion User vs. Non-User

Figure 5.21 shows that almost 70% of those that stated that their operation was impacted by congestion were toll road users. In contrast, most of those that stated that they in fact were not impacted by congestion were non-users (71%). Again, there were a few (29%) of the respondents that were toll roads users and stated they were not impacted by congestion. The reasons for using toll roads by these respondents were: time savings, less congestion, safer and shorter routes. A sample proportion test was conducted to test whether the proportion of toll road users that is impacted by congestion is greater than the proportion of non-toll road users that is impacted by congestion. The null hypothesis being tested stated that the proportions of toll road users and non-toll road users that indicated that their operations are impacted by congestion are the same at the 95% confidence level ($\alpha=0.05$). The Z-score obtained from this computation was 2.648 with a corresponding p-value of 0.004. Being that the p-value is less than 0.05 the null hypothesis can be rejected and we can state that there is a statistical difference between toll road users and non-toll road users' perception of congestion and how it impacts their operation.

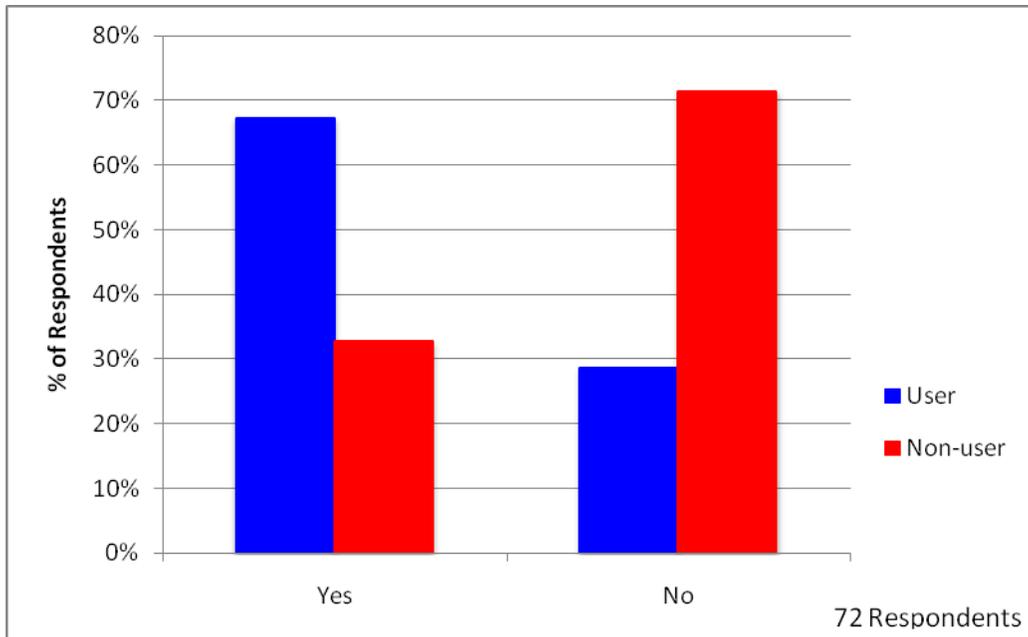


Figure 5.21 Operation Impacted by Congestion – User vs. Non-User

As seen in Figure 5.22 both the user and non-user group have a delivery window in which to make their deliveries, 91% and 81% respectively. A sample proportion test was conducted at to test whether the proportion of toll road users that has a delivery window is statistically different than the proportion for non-users. The null hypothesis being tested stated that the proportions of toll road users and non-toll road users that indicated that they made their deliveries within a specific delivery window is the same at the 95% confidence level ($\alpha=0.05$). The Z-score obtained from this computation was 1.662 with a corresponding p-value of 0.004. Being that the p-value is less than 0.048 the null hypothesis can be rejected and we can state that there is a statistical difference in the proportions of toll road users and non-toll road users that have a delivery window in which to deliver the major commodity transported by their company.

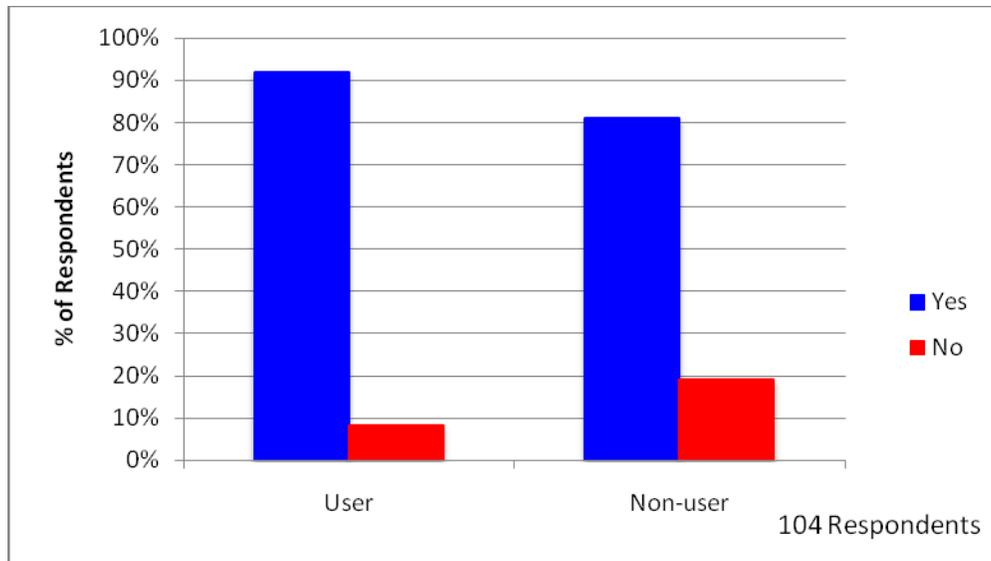


Figure 5.22 Delivery Window – User vs. Non-user

Figure 5.23 shows that both the user and non-user group transport time sensitive commodities, 82% and 70% respectively. A sample proportion test was conducted to test whether the proportion of toll road users that transported time sensitive commodities was statistically different than the proportion of non-users that transport time sensitive commodities. The null hypothesis being tested stated that the proportions of toll road users and non-toll road users that indicated that they transported time sensitive commodities is the same at the 95% confidence level ($\alpha=0.05$). The Z-score obtained from this computation was 1.454 with a corresponding p-value of 0.004. Being that the p-value is greater than 0.073 the null hypothesis cannot be rejected and we cannot conclude that there is a statistical difference in the proportions of toll road users and non-toll road users that transport time sensitive commodities.

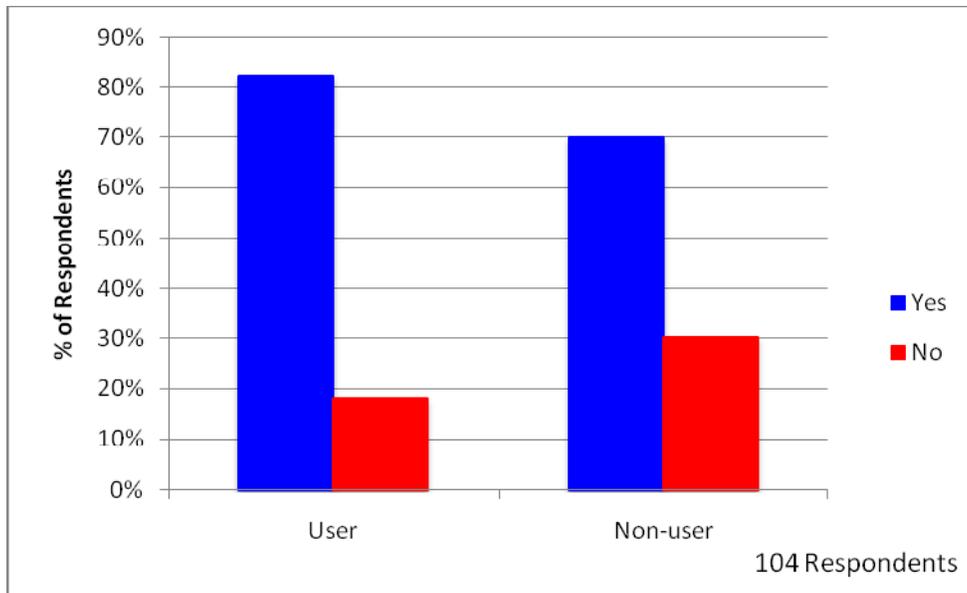


Figure 5.23 Time Sensitivity – User vs. Non-user

From the results shown in Figure 5.24, researchers noted that a higher percentage of toll road users (50%) stated that they conduct most of their business during the morning peak hours between 7:00am and 9:00am compared to non-toll road users. Similarly a higher percentage of non-toll road users make most of their deliveries between 9:00am and noon compared to toll road users.

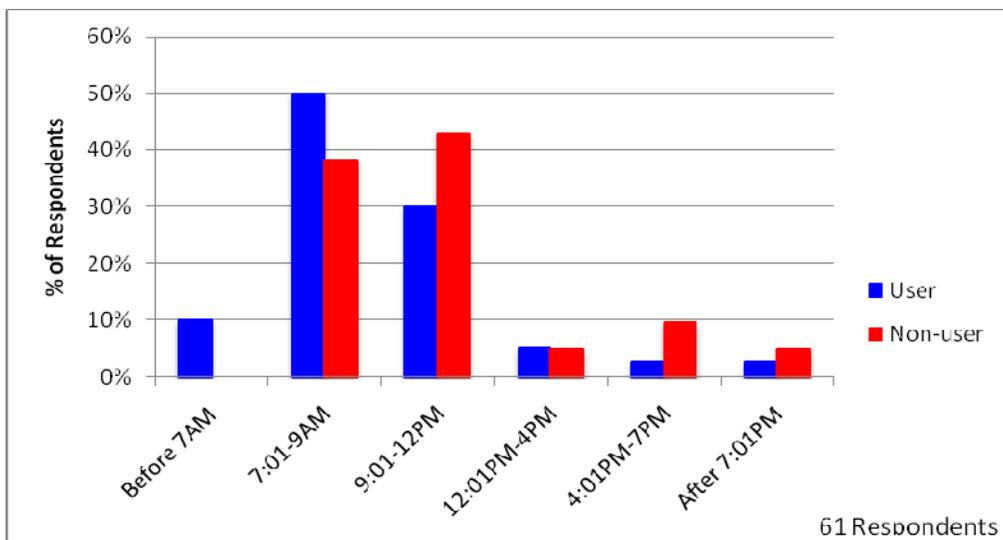


Figure 5.24 Time of Delivery – User vs. Non-user

Respondents were asked about their general support towards the construction of future toll roads. Results for this question, shown in Figures 5.25 and 5.26, were crosstab between users and non-users and between trucking sectors. Researchers expected that the results would demonstrate the tendency for non-users to express their anti-toll sentiment by stating that they did not support the construction of new toll road facilities. Conducting a chi-square analysis to test the null hypothesis that support for the construction of future toll roads in the Central Texas area is independent of toll road usage at the 95% confidence level ($\alpha=0.05$). The results obtained from this test indicated that the test statistic ($\chi^2=11.58$) is greater than the critical value ($\chi^2=7.81$), hence the null hypothesis can be rejected and it can be concluded that there is a statistical relationship between toll road users and support for the construction of future toll roads in the Central Texas area.

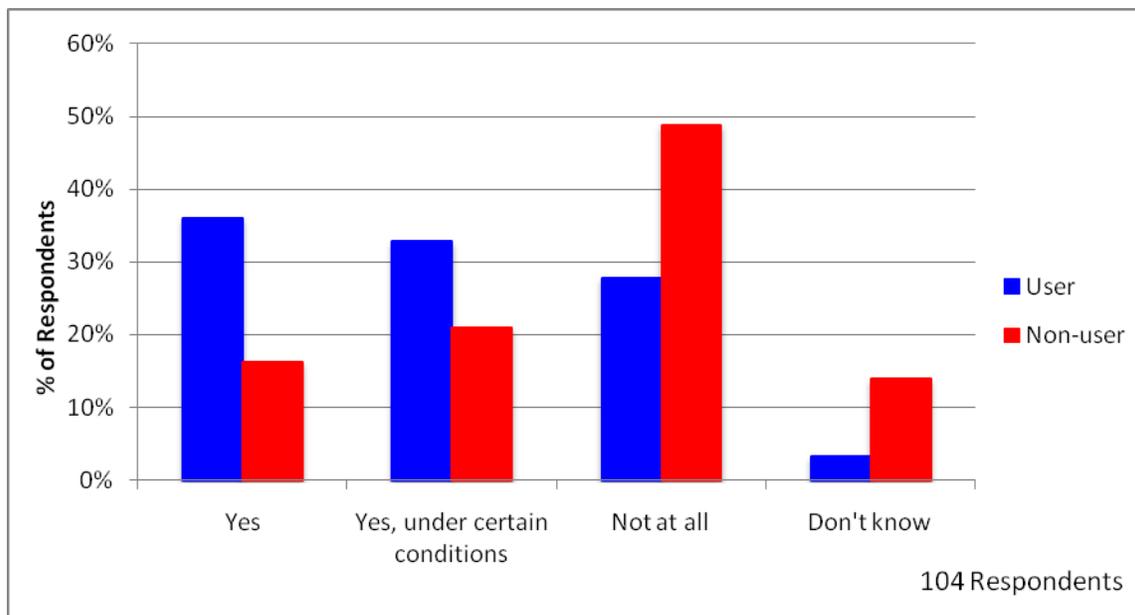


Figure 5.25 Toll Road Support – User vs. Non-User

The support for the construction of additional toll roads in Central Texas varied by trucking operation. From Figure 5.26 it is evident that support (i.e., respondents that said they support the construction of additional toll roads in Central Texas) comprised of LTL and Other (21% respectively), private carriers (18%) and TL and Parcel/Express (14% and 14% respectively). Conditional support was expressed by TL and private carriers, representing 34% and x% of the respondents that supported the construction of toll roads under certain conditions. Finally, TL

carriers expressed major opposition to the construction of additional toll roads in Central Texas, representing more than 40% of the respondents that did not support the construction of additional toll roads at all.

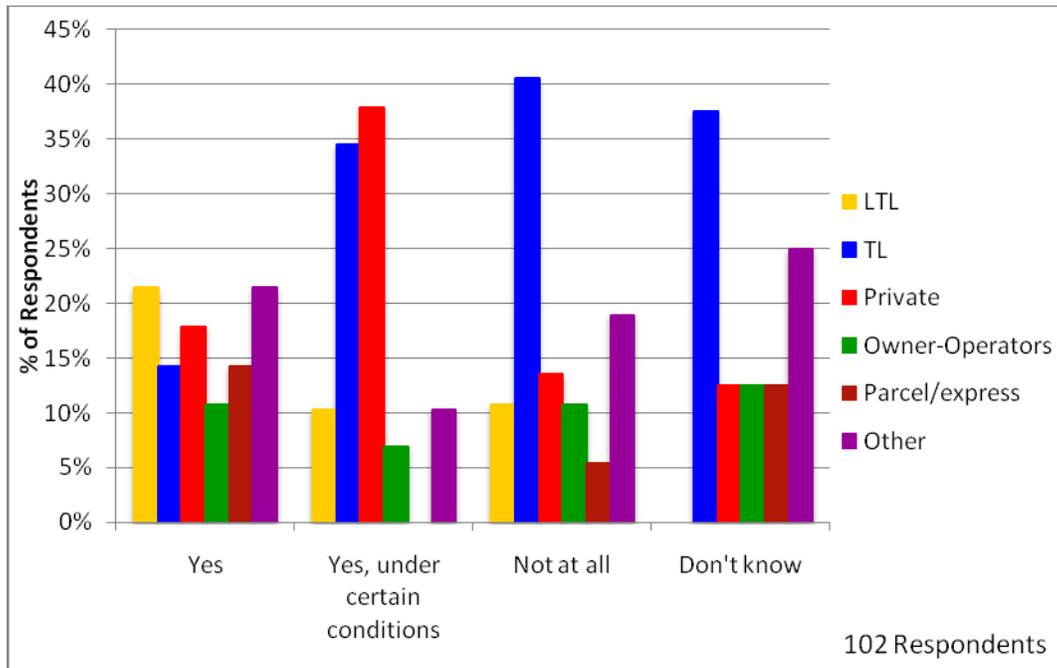


Figure 5.26 Toll Road Support by Type of Operation

Respondents were given a series of statements about toll roads and were asked to rank them depending on whether they strongly disagreed, disagreed, were neutral, agreed or strongly agreed with the statement. The results for these questions, for both users and non-users, are illustrated in Figures 5.27 through 5.34. As can be seen from Figure 5.27, when respondents were asked to state how they felt towards the statement that toll roads provide an alternative to congested freeways, 73% of the toll road users either agreed or strongly agreed with the statement in comparison with non-users were only 53% agreed or strongly agreed with the statement. In contrast, when examining those that answered that they strongly disagreed or disagreed with the same statement more of these responses came from non-toll road users (28%) as opposed to toll road users (10%).

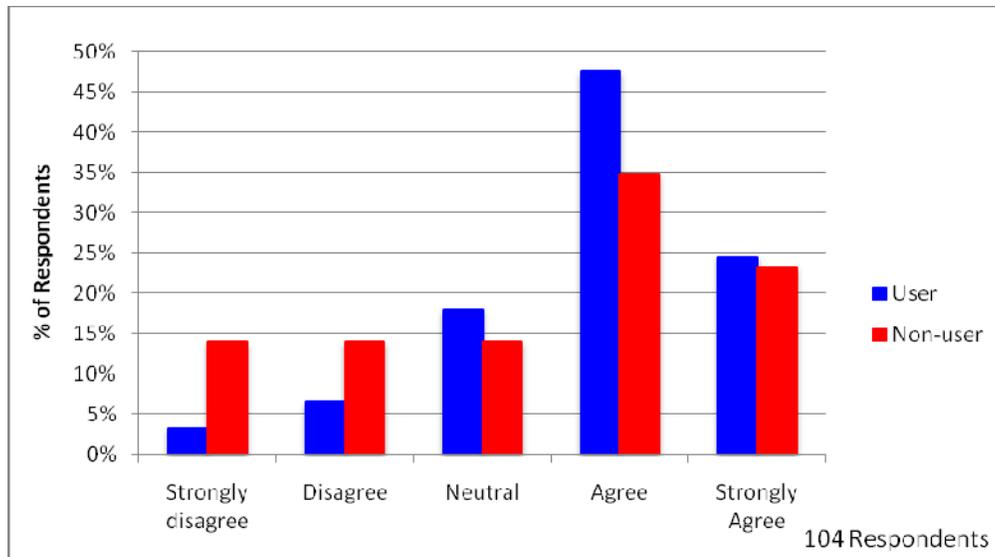


Figure 5.27 Toll Roads are an Alternative to Congestion - User vs. Non-user

Responses to the statement that toll roads have superior pavement conditions [than freeways] are shown in Figure 5.28. Of those categorized as toll road users, 55% answered that they agreed or strongly agreed with the statement and only 15% stated that they disagreed or strongly disagreed. On the other hand, 41% of non-users either agreed or strongly agreed with the statement and 33% disagreed or strongly disagreed.

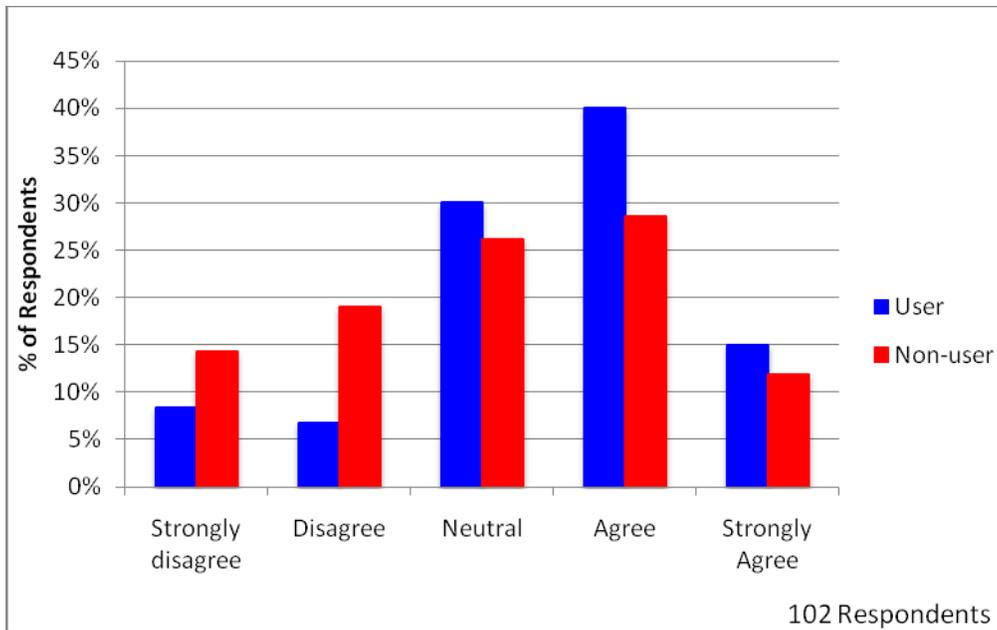


Figure 5.28 Toll Roads have Superior Pavements - User vs. Non-user

Figure 5.29 shows the responses regarding the statement that toll roads are faster. Both toll road users and non-toll road users seemed to agree with this statement as 65% of users and 53% of the non-users either agreed or strongly agreed compared to the 21% of non-users and 6% of users that strongly disagreed or disagreed with the statement.

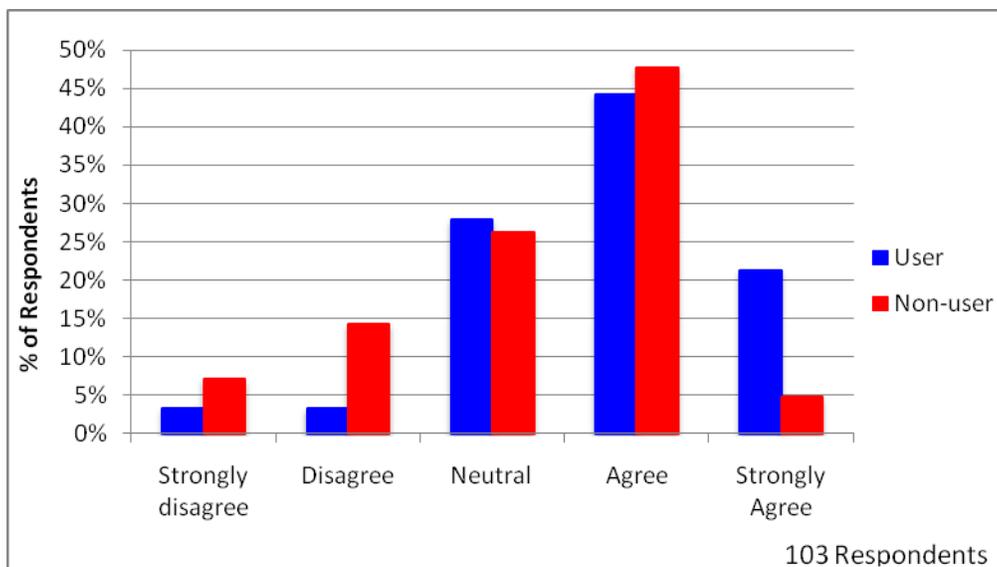


Figure 5.29 Toll Roads are Faster - User vs. Non-user

Responses to the statement that toll rates are reasonable considering the benefits are presented in Figure 5.30. As can be seen from the figure, 46% of toll road users agreed or strongly agreed with this statement in contrast to only 14% of the non-users that also agreed. However, 49% of the non-users and 36% of the users strongly disagreed or disagreed with the statement.

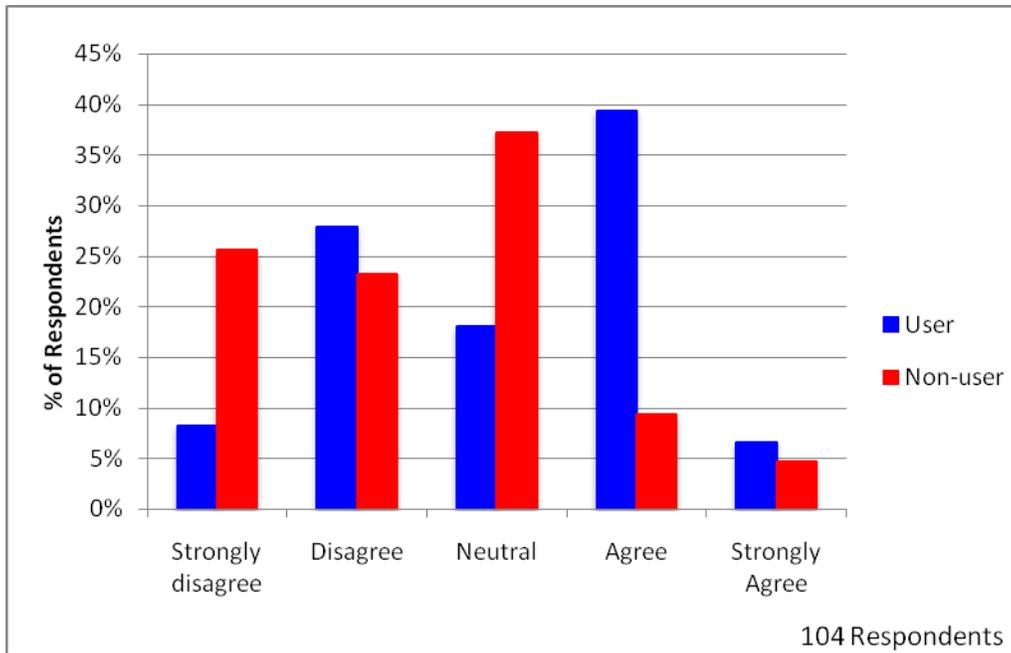


Figure 5.30 Toll Rates are Reasonable Considering the Benefits - User vs. Non-user

Figure 5.31 shows the responses obtained for the statement that toll roads are a safer alternative [to freeways]. When comparing users to non-users responses we can see that 50% of users and 29% of non-users agreed or strongly agreed with this statement. In contrast, 42% of the non-users strongly and 18% of the toll road users disagreed or disagreed with the statement.

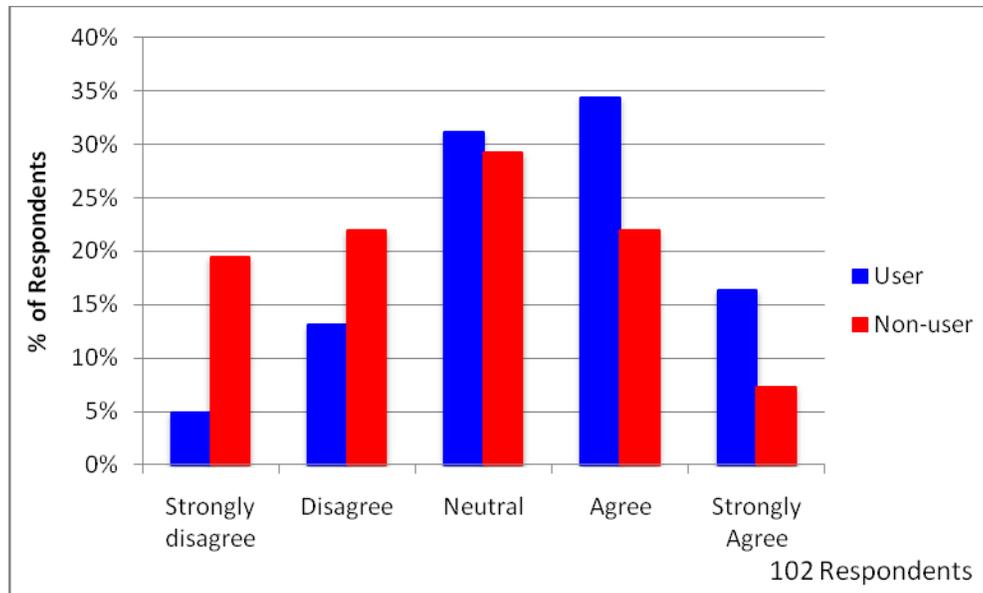


Figure 5.31 Toll Rates Provide a Safer Alternative - User vs. Non-user

Responses to the statement that toll roads provide more predictable travel time [than freeways] are shown in Figure 5.32. Of those categorized as toll road users, 62% answered that they agreed or strongly agreed with the statement and 15% stated that they disagreed or strongly disagreed. On the other hand, 48% of non-users either agreed or strongly agreed with the statement and 33% disagreed or strongly disagreed.

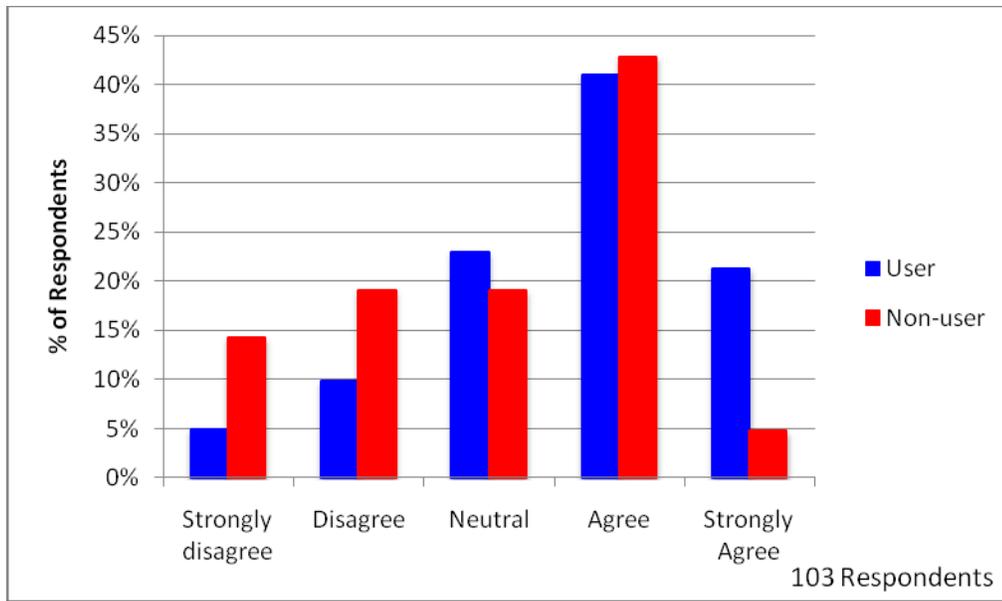


Figure 5.32 Toll Rates Provide More Predictable Travel Time - User vs. Non-user

Figure 5.33 shows the responses obtained for the statement that toll roads provide an alternative in emergency situations. When comparing users to non-users responses we can see that 61% of users and 46% of non-users agreed or strongly agreed with this statement. In contrast, 35% of the non-users strongly and 17% of the toll road users disagreed or disagreed with the statement.

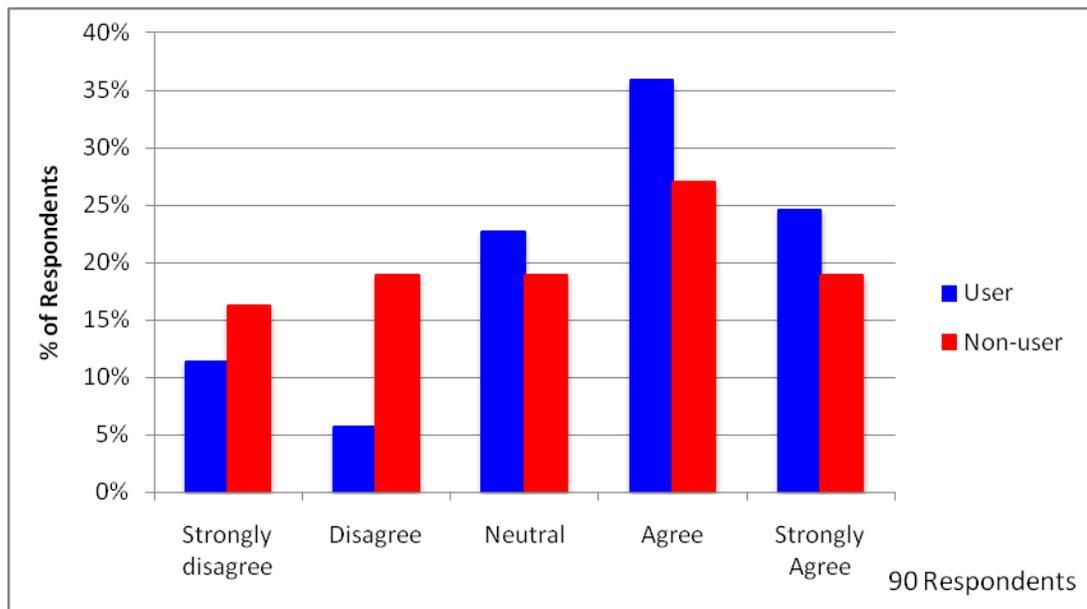


Figure 5.33 Toll Rates Provide an Alternative in Emergency Situations - User vs. Non-user

Respondents were asked to rank the following statement: we will use them [toll roads] when the shipper pays the toll. Responses to thi statement are shown in Figure 5.34. Of those categorized as toll road users, 42% answered that they agreed or strongly agreed with the statement and 29% stated that they disagreed or strongly disagreed. On the other hand, 35% of non-users either agreed or strongly agreed with the statement and 29% disagreed or strongly disagreed.

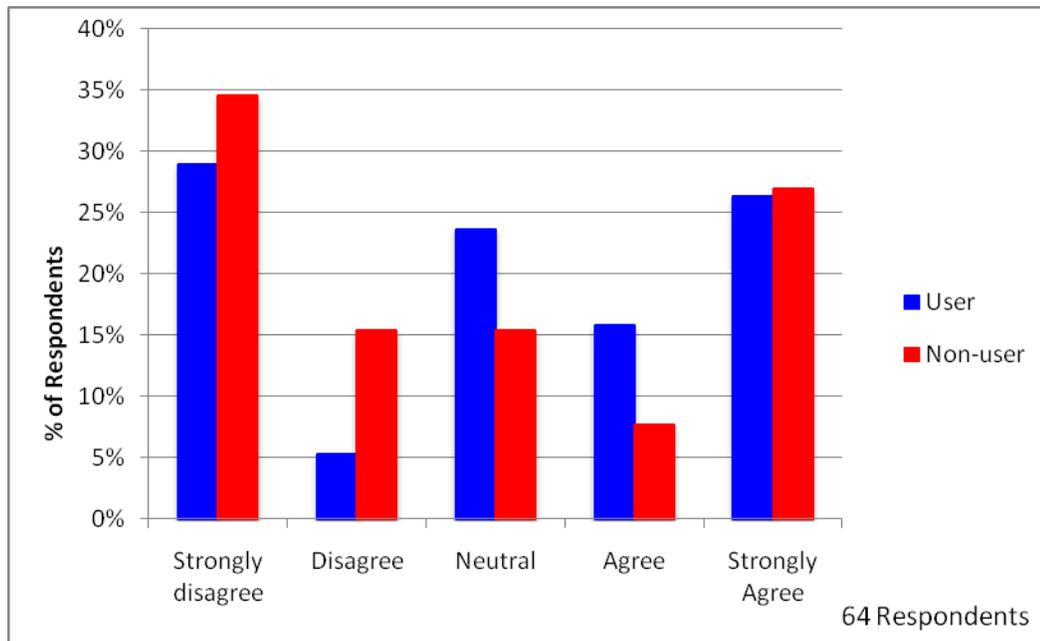


Figure 5.34 We Will Use Toll Roads if Shipper is Willing to Pay the Toll – User vs. Non-user

5.4 CONCLUDING REMARKS

The intent of this Chapter was to characterize truck toll road and non-toll road users. Truckers were characterized by type of trucking operation and whether or not they were toll road users. Some of the most relevant findings were:

- most truck carriers belief their operation to be impacted negatively due to congestion,
- the majority of truck carriers transport a time sensitive commodity and have to operate within a specified delivery,
- most of the toll road users indicated time savings as a major benefit in using toll roads,

- most toll road user fleets are equipped with an electronic toll tag and it is the company that is in charge of paying for the toll,
- most drivers are allowed to use toll roads all the time or by their own discretion,
- the two major reason for not using a toll road were either because none are available in their area or because the costs are too high,
- the majority of the non-toll road users are willing to pay a for the use of a toll road in order to avoid congestion,
- most non-toll road users would consider using a toll road if a fuel tax refund were implemented for the miles travel on a toll road.

The statistical analysis did conclude that there are significant different in the perception of toll roads between a toll user and a non-user.

CHAPTER 6. CONCLUSIONS

Previous studies have concluded that truck sector's response to road pricing is highly variable; it depends on location, industry sector, commodity type, and trip distance. This research study attempt was to be able to characterize truck toll road users and non-toll road users in the Central Texas toll road area. The research team conducted a survey of truck carriers to determine the general characteristics of the trucking sector as well to their perception of toll roads to be able differentiate between both groups.

The survey concluded that the majority of truck carriers perceive congestion as a major problem that has a big impact in their operations. Most survey respondents indicated they transported a time sensitive commodity that had to be delivered within a time window of one to two hours (31%) and statistical analysis indicated that there is a relationship between this time sensitivity and toll road usage.

Current toll road users tend to be more favorable in their perception of toll roads, this was confirmed using a chi-square statistical test that determined that users tend to be more in favor of the construction of new toll roads in the Central Texas area. Toll road users indicated that the major benefits their company received with the usage of a toll road were an increase in time savings (39%) and a reduction in congestion (30%).

In contrast, non-toll road users indicated that the reasons for not using a toll road were that it cost too much (35%) or that there were no toll roads in their area of operation (35%). This latter group is very important since they could be potential users once the SH 130 is completed providing a bypass around the Austin area that would avoid congestion in the I-35 corridor. The majority of the respondents (73%) travel along the I-35 corridor.

When providing non-toll road users with incentives that would divert them to a toll road the researchers found a very strong negative sentiment towards toll road in general. Very few respondents were willing to even answer these questions and most of those that did respond were either not interested in any incentive or stated that they may be interested. The incentive that

resulted in the most positive response was the provision of a fuel tax refund for the miles traveled on a toll road.

Also of interest was the fact that most truck carriers are paid per load (34%), which could mean that if toll roads provide a significant amount of time savings by avoiding congestion the carriers could make more deliveries per day, resulting in potential increase in truck toll road users.

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Appendix A:
Literature Review

Economic and Financial Feasibility of Truck Toll Lanes – Holguin-Veras et al.

Holguin Veras, et al (2003) analyzed the economic and financial feasibility of Heavy-Truck Toll lanes (HTL). The team's research was based on the Comprehensive Truck Size and Weight Study (TSWS), which stated that an increase in truck size and weight could reduce truck vehicle miles and increase economic productivity. The authors' approach to evaluating the feasibility of Heavy Truck Lanes (HTL) differs from the TSWS in that it proposes the use of segregated facilities. They state that by using a segregated facility the cost of investment are greatly reduced, since upgrades are only needed in the heavy-truck lane and not on the entire facility.

The concept of the HTL presented in this study involve an increase in the weight limits and truck sizes; financing the construction and operation through private investments (tolls); and providing rebates on gas taxes to trucks using the facility. For this concept to be implemented it would require the provision of right-of-way along the existing highway corridors on the federal aid system; relaxing current federal truck size and weight regulations for trucks that use the proposed system; and a rebate of federal, state, and local gas taxes for miles driven on the HTL system.

The authors analyzed a hypothetical study corridor which consisted of three mixed-traffic lanes (MTL) used by passenger cars, buses, and non-paying trucks that are physically separated from an exclusive HTL using continuous New Jersey barriers. HTLs would be one lane in each direction – with a passing lane every few miles and on hills – and with shoulders on the inner and outer edges. HTLs would also have their own exclusive entrance and exit ramps and adjacent staging areas to provide for the loading and unloading of conventional truck combinations that will go on to use local freeways and arterials.

The study estimated the productivity impacts of the HTL configuration using the 3-S2 and 3-S2-T4 truck combinations. The former was used since it is the most widely used truck combination and the latter is the largest capacity truck allowed among current combinations. The axle load limits for the HTL were 50% higher than the higher axle loads currently allowed in the U.S.

Productivity analyses were based on costs provided by trucking companies. The cost components analyzed were travel time, distance, cargo handling, and a fixed cost. The analysis showed that

if the amount transported is less than or equal to 15 metric tons, the HTL configurations are more expensive than the base cases (Case A: tight gross weight limits, Case B: high gross weight limits). If the amount transported is more than 15 tons, then the HTL becomes less expensive for trip distances greater than 40 km.

When estimating commercial vehicle tolls, the following should be considered: objective of pricing entity; user's willingness to pay; marginal costs of pavement deterioration; traffic congestion; and existing capacity constraints. For this study a simple estimation was performed considering the following parameters: the maximum toll allowable could not be higher than the difference between operational costs on the base case and the HTL. The analysis made the assumption that for an HTL to be attractive to trucking companies, 50% of the cost savings for using HTL tolled facilities would have to be in direct operational costs. The other 50% of the savings is left as an incentive. To calculate the unit toll per distance the total toll was divided by the distance. The results demonstrated that the net savings increases with distance traveled; for the 3-S2 configuration and the breakeven distance is more than 23km for the 3-S2-T4 configuration the breakeven distance is more than 68km.

The feasibility analyses for the HTL system looked at the economic feasibility from the point of view of the whole system and at financial feasibility from the point of view of a private investor. The economic indicators considered were: the cost of building and operating the HTL; vehicle operating cost savings; and travel time savings. The financial feasibility analysis included these indicators, plus the toll revenues. Both financial and market prices were used.

Instead of conducting a detailed estimate of the initial investment, researchers calculated an approximate pavement cost and complimented it with a sensitivity analysis. The results were a basic investment cost of \$425,000/lane-km for the MTL systems, and \$600,000/lane-km for the HTLs. Additional sensitivity analyses were conducted to include the costs of the expenses of building ramps and terminals and retrofitting the existing structures.

To estimate the benefits of HTL, the authors used the Highway Design and Maintenance Standards Model (HDM) developed by the World Bank, which enabled them to calculate road

user cost in terms of pavement deterioration. The analysis demonstrated that by using HTLs, the rehabilitation of MTLs will be postponed (1.5 trucks in MTLs will be replaced by 1 truck in an HTL).

To calculate the return on investment (ROI) they calculated the cost of building and operating the system and the toll revenues using three toll scenarios: \$0.05/km, \$0.25/km, and \$0.50/km. The analysis showed that for the HTL to be feasible the toll would have to be greater than \$0.05/km; a 1:1 truck shift is more profitable than a 1.5:1 shift (opposite to the results obtained in the benefits analysis of the economic resources savings). The feasibility of the system will ultimately depend on demand.

The study concluded that an increase in gross weight limits like the ones proposed by the researchers will lead to an increase in payloads, thus, impacting operational costs. The feasibility analyses determined that even with low traffic levels, the HTLs will have a positive economic effect and this will increase as traffic levels increase. The effect of a change in the initial investment hardly affects the economic feasibility. In order for HTLs to be financially feasible the tolls need to be between \$0.25 and \$0.50/km to generate a higher rate of return than the opportunity cost of the capital. ROI is sensitive to the amount of daily traffic and to the initial investment, the authors concluded that HTL presents a good investment opportunities for the private sector.

Impacts of Time of Day Pricing on Travel Behavior: General Findings from the Port Authority of New York and New Jersey's Initiative – Holguin-Veras et al.

Holguin-Veras (2007) researched the impact produced by time of day pricing, focusing on three main areas: user impacts, traffic impacts, and institutional analyses. People that favor road pricing point out that it is the answer to solve congestion problems since it has been demonstrated that building new capacity does not work. On the other hand, those that oppose base their argument on the perception of double taxation and the impact it would have on lower income individuals.

The authors studied the effects of a time-of-day pricing initiative implemented by the Port Authority of New York and New Jersey (PANYNJ) on their toll facilities in March 2001. Toll pricing for the PANYNJ facilities now depend on the time of day on which you travel through them, the payment technology used, and the vehicle type. Toll discounts are only available to electronic toll collection (E-ZPass) users. The reasons for implementing this pricing mechanism was to help finance the PANYNJ capital budget, reduce congestion, increase the use of mass transit and E-ZPass, and ease commercial traffic management.

Holgui-Veras et al. conducted two surveys by means of computer aided telephone interviews in an attempt to capture the behavioral changes of two groups of users; passenger and commercial vehicles. The carrier survey focused on companies located in New York and New Jersey. The sample was drawn from a commercial database. The survey gathered data about the company attributes, behavioral changes after the time-of-day pricing initiative was implemented, current operations and travel flexibility, usage of E-ZPass, and awareness of toll discounts.

Of the 200 truck observations, 91% were current regular users, and 18% were former regular users of the toll facilities, 48.5% were for-hire carriers and 51.5% private carriers. The regular users tended to be Less-Than-Truckload (LTL) or Full Truckload (FTL) operations, operating medium to large fleets, owning more large size trucks and operating in New York and New Jersey.

When asked about behavioral changes following the time-of-day pricing initiative, 20.2 % of the respondents indicated they changed their behavior (this includes increasing shipping charges)⁷. Those that changed their behavior tended to be FTL operations since these companies have more route alternatives. Local deliverers usually do not have many alternatives since they would require the approval of receivers to change their time of travel. Respondents that did not change behavior indicated that they did not have any time-of-arrival flexibility (usually for-hire carriers). Most of the regular users are currently using E-ZPass to travel through the toll facilities, but they were not fully aware of the toll discounts available.

⁷ 19.3% when excluding shipping charges as a behavioral change

The authors concluded that to understand the impacts of road pricing, more research is needed to determine receiver reactions to the increase in shipment charges incurred by carriers.

Exploring Truck Driver Perceptions and Preferences: Congestion and Conflict, Managed Lanes, and Tolls – Adalakun and Cherry

Adalakun and Cherry (2008) focused on understanding truck drivers' perceptions of urban congestion and safety challenges, and tried to identify truck preferences for potential geometric or operational solutions. The study was conducted by means of an intercept survey. Five hundred truck drivers were interviewed at a truck stop or truck plaza that serves two major interstate highways near Knoxville, Tennessee. Their targets were truck drivers traveling through the Knoxville urban area.

The survey was designed not to overwhelm truck drivers. Simple wording was used for the questionnaire to ensure the interviewees understand the questions and provide correct responses. The survey gathered data about operator status, years of driving experience, trip origin and destination, Knoxville area destinations, frequency of Knoxville highway usage, perception of congestion in Knoxville, schedule adjustments, perceptions of lane configurations, factors that reduce efficiency and safety, impacts of smaller vehicles on truck safety, and willingness to pay tolls.

Of the data collected, 47% of the respondents were owner operators and 53% worked for a trucking company. Owner operators conducted longer and fewer trips through the Knoxville area. Both types of truck drivers agreed that they experience severe congestion through the area, but only half indicated that they change their itineraries or routes to avoid it. In terms of safety and efficiency, most truck drivers indicated that the greatest threat to their productivity and safety were aggressive drivers, lane changing behavior, congestion, and merging cars.

When asked about lane configurations, most respondents supported the use of left side lanes as truck lanes (reversing the current lane configuration). There was also great support for the option of a managed truck only lane. Both of these configurations would face operational challenges, such as trucks moving and exiting to the right side off-ramps. However, the truck

drivers that supported optional truck only lanes were not willing to pay more to avoid congestion than those that supported other operational changes. The average willingness to pay to save ten minutes of travel time was \$2. This results in an average value of time, from the truck driver's perspective, of \$10 per hour.

The researchers are planning to incorporate these findings in micro-simulation models to calculate the effects of the different design configurations that would provide the highest levels of capacity improvements and be acceptable to drivers.

Survey of Motor Carriers Opinions on Potential Optional Truck Only Lanes on Atlanta Interstate Highways – Jeffrey Short

Short (2007) explored the willingness of truck carriers to pay for the use of an optional truck only toll (TOT) lane on the Atlanta interstate highways. The State Road and Tollway Authority (SRTA) determined that the financing of a TOT system would depend on the willingness of trucking companies to pay for the use of the facilities. The researchers interviewed 71 Georgia based trucking firms to characterize their use of highways, their time of travel, the option of using alternative routes, the criticality of their shipments, and their willingness to increase costs in exchange for real/perceived benefits from using the TOT system.

Of those trucking firms interviewed 68% were for-hire carriers (i.e., 49% TL and 19% LTL), and 26% were private carriers. The survey results suggested interest in an increase in capacity and congestion mitigation, especially the use of TOT lanes if these were non-tolled. This means that, a pricing mechanism is required for a TOT lane to operate at free-flow speeds. Finally, the researchers pointed out that shippers usually establish delivery times and carriers travel during peak hours, this indicates that congestion will continue to be a problem in spite of the carriers changing behavior, and it is shippers' behavior that needs to be influenced.

Toll Truckways: A New Path toward Safer and More Efficient Freight Transportation – Poole, et al.

Poole, et al (2002) argued that the US needs a new approach towards long-distance inter-city trucking, since the current system often leads to conflicts between passenger vehicles and trucks

and limits the potential productivity of long-haul trucking. To mitigate these problems, the authors of this study proposed the use of self-financing toll truckways that would consist of one or more truck only lanes (each way) that are physically separated from existing lanes by New Jersey concrete barriers. These proposed truckways will have their own entry and exit ramps. Truckways will allow for the use of longer and heavier trucks greatly increasing freight productivity. Also, building specialized lanes for larger and heavier trucks will greatly reduce the amount of funding required to improve the existing system to allow for greater use of longer combination vehicles (LCVs). Along with the increase in transportation efficiency, there will also be an safety enhancements since trucks and passenger vehicles will be physically separated.

Studies have shown that the most significant contributors to pavement deterioration are a combination of factors, such as axle weight loading, axle configurations, tire width, tire pressure, and suspension characteristics, rather than gross vehicle weight. Of these factors, axle configuration, tire width and pressure, and suspension characteristics are basically unregulated by federal or state governments. Also, federal regulations do not take into account three-axle combinations (tridems), which spread loads more evenly and has a less deteriorating effect on the pavement as opposed to the tandem axle group.

In terms of bridge load protection, the bridge formula is used that restricts the maximum weight allowed on any group of consecutive axles considering the number of axles in the group and the distance from the first to the last axle, (Ibid, VI-9). The authors state that since this bridge formula is used for bridge protection and axle loads limits are used for pavement protection, gross weight restrictions are unnecessary and redundant. Also, they argued that from a safety perspective, gross weight restriction is ineffective since a passenger vehicle will be destroyed in a collision with a large truck regardless of the truck's weight. Safety concerns would be addressed if passenger cars and trucks are separated wherever possible, trucks are manufactured more stable and have better handling, more efficient combinations are allowed that will increase productivity, and if freight could be moved using fewer trucks. An increase in productivity will yield and increase in revenue that could promote the adoption of improved safety measures, and the use of high technology to help truck drivers become safer and more productive.

LCVs generally operate on rural roads and turnpikes and have a good safety record in these operational environments. But the authors indicated that it would be difficult to predict how they would operate in more urbanized areas where there is more congestion. There is also an issue involving the debate over truck and railroad competition. The railroad industry have argued that if by allowing larger trucks to operate, truck transportation would become more efficient and the rail sector incur economic losses. Both these issues can be addressed with a tolled truckway. In terms of safety, it will reduce the number of trucks on mixed traffic lanes. In terms of the rail sector, if trucks are charged a sufficient amount for the use of the truckway they will be paying for their usage just like trains pay for the use of the tracks. There will also be environmental benefits from using LCVs since they would reduce vehicle miles traveled, fuel consumption, and emissions.

Although there will be cost saving from allowing the LCVs to operate on the existing mixed traffic facilities, the cost of upgrading it to the necessary standards will be too high. It is more economical to build a new truck lane or convert and upgrade an existing lane for truck only use than to upgrade all lanes.

The authors presented the Canada and Australia cases to prove their point that LCVs are safer and more productive, as has been the case with the use of these in both countries. In the case of Canada, the tridem axle grouping has been proven to be superior to tandems and that the use of B-trains was preferred over the conventional full trailer of A-train arrangement with drawbar attachment. Research done in Canada indicate the low U.S. loading limit as a source of major inefficiency in the container trade between Seattle and Vancouver, since Canadian provinces generally permit heavier loads, although they impose stricter length regulations. The study concluded that Canadian trucking has benefited from the Canadian federal government acting as a facilitator rather than decision maker in terms of truck sizes and weight limits. Reform in this area has come through research and collaboration among interested parties, and agreements amongst provinces.

In the case of Australia, the use of the B-train is preferred because it connects the trailer closer to the tractor, which reduces trailer wander. Axle-loading limits are higher than in the US but these

are only for certified road-friendly suspension systems. These suspension systems are estimated to cause 10 to 20 percent less damage to pavements. The use of LCVs has improved safety and road maintenance costs have not increased. The additional cost imposed on bridges is offset by the lower costs of freight.

As part of this study, the authors also include see toll truckway feasibility analysis. (See to Holguin-Veras et al, (2003) entitled Economic and Financial Feasibility of Truck Toll Lanes).

To implement a toll truckway system several issues need to be addressed: such as, the physical configuration of the truckway, the relationship between tolls and existing highway user taxes, and the use of new technologies. For truckways to be effective, the pavement design should be stronger and more durable than the typical design for mixed use lanes. If a project is financed by the private sector, investors are likely to build the truckway to a heavier standard, so as to have pavements with longer life and lower repaving costs.

To address concerns about “double taxation” the user taxes paid for the miles driven on the toll truckways can be rebated. Another option is for the toll operator to receive the rebates instead of the individual trucking companies. The trucking company could then set up accounts with the operator to deposit funds to cover total toll costs.

State DOTs will greatly benefit from the toll truckway since it would be providing for an additional lane that was probably already needed to be build by the DOT, and divert 20 to 25 percent of existing heavy truck traffic off the existing lanes, reducing pavement consumption and maintenance and rehabilitation expenditures.

The authors propose that the concession agreements include one of two models when setting toll rates. The first model sets a ceiling on the rate of return that can be earned during the concession period. This is helpful when there will be a need for traffic management since it does not control toll prices directly. The other model negotiates a future rate schedule based on an inflation index and traffic levels. Also, there would be no toll plazas since the proposed toll truckway would implement the newest electronic toll collection technology. This would require for each truck to

have a transponder encoded with its size and weight and for the trucking firm to maintain a prepaid account with the truckway operator.

According to the authors, there are two scenarios in which toll truckways can be implemented. The first is to extend the territory in which LCVs can operate, in which case the truckway will be serving as a “bridge” across those states which currently do not allow for LCV operations. The second would use toll truckways to help meet US trucking obligations under the NAFTA agreement, which seeks to harmonize operating standards among the US, Canada and Mexico.

The authors emphasized that none of this will be possible without some policy changes by the federal government, including the provision of right of way for toll truckways along existing Interstate and National Network corridors, the easing of current federal size and weight restrictions, and the implementation of federal and state tax rebates for the use of the tolled truckway.

State Highway 130 Value Pricing Project for the Austin District – Geiselbrecht et. al.

Geiselbrecht et al (2008) researched the possibility of using innovative pricing incentives as a means to encourage truck carriers to use the SH 130 toll road in Austin as an alternative route to the congested I-35. SH 130 is 12 miles longer than the untolled I-35, making it an unattractive option for truck users. The authors examined literature that dealt with truck route choice and the financial incentives that could impact their route choice. They also conducted interviews with different types of trucking companies, which confirmed what had been found from the literature review. The authors concluded that trucking companies avoid using toll roads under most circumstances and that depending on their type of operation, carriers react differently to different tolls and incentives to encourage toll road usage.

The researchers developed and administered an online and a mail out survey. A total of 2,023 valid responses were obtained. The survey gathered information about the type of operation, delivery flexibility, travel behavior, perceptions towards proposed incentives, and various travel scenarios. The survey results showed that a small amount of time savings has little benefit to a truckers’ delivery schedule since only 6% reported a delivery time window of less than one hour. The survey results also showed that drivers plan to avoid congestion and that the incentives that

were most favored were those that directly impact costs, such as reduced fuel price and off-peak discounts.

Since the trucking industry is segmented into different operation types, different factors influence their route choices and perceptions about incentives. Current toll rates are equivalent to the per mile cost of fuel, which, is the most expensive operating cost component. In general, owner-operators will avoid using a toll road at all costs, while delivery firms will weigh the costs and benefits before making a decision. The incentives that were the most desirable were the reduced fuel prices along the toll road and off-peak discounts. Also, the survey showed that those trucking companies that traveled during the afternoon peak hour period are more willing to use the toll road. The responses also varied depending on what type of cargo was transported. For example, carriers that transport refrigerated goods were more likely to use the toll road.

After identifying the incentives favored by carriers, the researchers analyzed the potential costs and benefits to the trucking companies of using SH 130 and the added cost of the incentive to the toll road operator. These costs were estimated for the year 2015, i.e., the year in which congestion on I-35 is predicted to reach its peak and therefore resulting in more truckers using the SH 130 toll road. From the survey, the authors estimated a value of time of \$34.49/hour and time savings for the completed SH 130 were estimated to be between 11.6 minutes in off-peak hours, between 33.6 and 47.7 minutes in the AM peak hour and between 13.9 and 19 minutes Southbound and between 36.9 and 51.7 Northbound in the PM peak hour. The calculated benefit cost ratio was 1.36, suggesting that, although the incentives to shift truck traffic to the toll road would outweigh the costs, the overall costs of implementing the incentives could ultimately result in the costs outweighing the benefits.

Appendix B:
Survey Questionnaire

Truck Toll Survey (1)

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Truck Companies' View of Toll Roads



Page 1 - Heading

Your Company

Page 1 - Question 1 - Choice - One Answer (Bullets)

How would you describe your trucking operation? (Select only your primary type of operation)

- Less-than-truckload (LTL)
- Truckload
- Private fleet
- Owner operator
- Parcel/express
- Specialized (e.g. HazMat)
- Intermodal
- Other, please specify

Page 1 - Heading

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Page 1 - Question 2 - Choice - Multiple Answers (Bullets)

Please mark the truck types that your company owns or operates. (Check all that apply)

- Class 5: 3-Axle, Single Units
- Class 6: 4 or more Axles, Single Units
- Class 7: 3-Axle, Single Trailers
- Class 8: 4-Axles, Single Trailers
- Class 9: 5-Axles, Single Trailers
- Class 10: 6 or more Axles, Single Trailers

- Class 11: 5 or less Axles, Multi-Trailers
- Class 12: 6-Axles, Multi-Trailers
- Class 13: 7 or more Axles, Multi-Trailers

Page 1 - Question 3 - Open Ended - One or More Lines with Prompt

What is the size of your operation in Texas?

- Number of Single Units
- Number of Truck Tractors
- Number of Trailers
- Number of Truck Drivers

Page 1 - Question 4 - Open Ended - One Line

In which Texas county is your main office located?

Page 2 - Heading

Your Operation

Page 2 - Heading

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Page 2 - Question 5 - Open Ended - One or More Lines with Prompt

What percentage (%) of your operation is:

- Local haul (less than 50 miles)
- Short haul (50 to 200 miles)
- Medium haul (201 to 500 miles)
- Long haul (more than 500 miles)

Page 2 - Question 6 - Choice - One Answer (Bullets)

Would you describe congestion in Central Texas as a

- Major problem
- Moderate problem
- Minor problem
- No problem at all
- Don't know

Page 2 - Question 7 - Yes or No

Is your operation impacted by congestion?

- Yes
- No

Page 2 - Question 8 - Choice - Multiple Answers (Bullets)

If Yes, how is it impacted? (check all that apply)

- Higher fuel costs
 - Higher labor costs
 - Higher insurance/safety costs
 - Fewer deliveries (less business)
 - Driver retention
 - Other, please specify
-

Page 3 - Heading

Your Operation

Page 3 - Heading

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Page 3 - Question 9 - Open Ended - One Line

In a representative year, what is the major commodity (for example, perishable products) transported by your company?

Page 3 - Question 10 - Yes or No

Would you consider this commodity to be time sensitive?

- Yes
- No

Page 3 - Question 11 - Yes or No

Do you have a delivery window in which to deliver this commodity?

- Yes
- No

Page 3 - Question 12 - Open Ended - One Line

If Yes, how wide is the average window for on-time delivery (hours)?

At what time do you make most of your deliveries?

- Before 7:00 AM
- 7:00 AM to 9:00 AM
- 9:01 AM to 12:00 PM
- 12:01 PM to 4:00 PM
- 4:01 PM to 7:00 PM
- After 7:01 PM

How are drivers compensated? (check all that apply)

- Per load
- Per mile
- Per hour
- Other, please specify

If more than one compensation method is used, how is the method determined?

Do you supply your drivers with predetermined routes?

- Yes
- No

What percentage (%) of your costs comprise:

- Driver salaries and benefits
- Maintenance and tires
- Capital / Depreciation
- Fuel
- Taxes, permits and licenses
- Insurance
- Overhead
- Other, please specify

Your Use of Toll Roads

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

There are several toll roads in Dallas, Houston, and Central Texas. Have your drivers used or are they frequently using any of these toll roads?

- Yes [Skip to 5]
- No [Skip to 8]

Your Use of Toll Roads

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

What are the benefits of using toll roads?

How frequently do your drivers use toll roads?

- Daily
- 1-2 days per week
- 3 or more days per week
- 1-2 times per month
- Less than once per month
- Other, please specify

Who is responsible for paying the tolls?

- Driver [Skip to 7]
- Company [Skip to 6]

Your Use of Toll Roads

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Do all power units have an electronic toll tag that can be used to pay tolls?

- Yes
- No

When are drivers allowed to use the toll roads?

[Skip Unconditionally to 9]

Your Use of Toll Roads

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Would your company be willing to pay a toll if it: (Check all that apply)

- Saved travel time
- Allowed higher speed limits
- Allowed higher weight limits
- Offered separate lanes for trucks
- Avoided congestion
- Other, please specify

If you checked 'saved travel time", how much time needs to be saved before your company would be willing to pay a toll?

- 10 minutes
- 15 minutes
- 30 minutes
- 60 minutes
- Other, please specify

Page 7 - Question 26 - Open Ended - One or More Lines with Prompt

If you checked, "saved travel time", how much would your company be willing to pay for that travel time saving?

- \$ for a 10 minute time saving
- \$ for a 15 minute time saving
- \$ for a 30 minute time saving
- \$ for a 60 minute time saving
- Other, please specify

[Skip Unconditionally to 9]

Page 8 - Heading

Your Use of Toll Roads

Page 8 - Heading

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Page 8 - Question 27 - Open Ended - Comments Box

Why are your drivers not using toll roads?

Page 8 - Question 28 - Open Ended - Comments Box

Under what circumstances would your drivers use a toll road?

Would your company be willing to pay a toll if it: (Check all that apply)

- Saved travel time
 - Allowed higher speed limits
 - Allowed higher weight limits
 - Offered separate lanes for trucks
 - Avoided congestion
 - Other, please specify
-

If you checked 'saved travel time", how much time needs to be saved before your company would be willing to pay a toll?

- 10 minutes
 - 15 minutes
 - 30 minutes
 - 60 minutes
 - Other, please specify
-

If you checked, "saved travel time", how much would your company be willing to pay for that travel time saving?

- \$ for a 10 minute time saving _____
- \$ for a 15 minute time saving _____
- \$ for a 30 minute time saving _____
- \$ for a 60 minute time saving _____
- Other, please specify _____

Please indicate if your company would use the Central Texas toll roads if you could:

Subscribe to a toll road use plan, where you pay a discounted, fixed monthly fee for a specified amount of usage, similar to a cell phone plan

- Yes
- No
- Maybe

Page 8 - Question 33 - Choice - One Answer (Bullets)

Receive frequent user discounts, for example, free toll road days, free weekends, discounted toll rates, etc.

- Yes
- No
- Maybe

Page 8 - Question 34 - Choice - One Answer (Bullets)

Use the toll tag to pay for other driver purchases, for example, fast food, parking, fuel, etc.

- Yes
- No
- Maybe

Page 8 - Question 35 - Choice - One Answer (Bullets)

Receive a discounted toll rate during off-peak hours

- Yes
- No
- Maybe

Page 8 - Question 36 - Choice - One Answer (Bullets)

Use larger, well maintained truck stops with dining and truck repair facilities as well as, in-cab auxiliary power systems (such as IdleAire) alongside the toll road

- Yes
- No
- Maybe

Page 8 - Question 37 - Choice - One Answer (Bullets)

Get a fuel tax refund for the miles driven on the toll road

- Yes
- No
- Maybe

Page 8 - Question 38 - Choice - One Answer (Bullets)

Use Longer Combination Vehicles (LCV) on the toll road

- Yes
- No
- Maybe

Your Perception of Toll Roads

Please answer all of the following questions in terms of the primary type of operation selected in Question 1.

Do you support the construction of additional toll roads in Central Texas?

- Yes
- Yes, under certain conditions
- Not at all
- Don't know

Do you think there are better alternatives for relieving traffic congestion than toll roads?

- Yes
- No

If Yes, what are they?

Please check the number that best describes how you feel about toll roads (1 means strongly disagree, 5 means strongly agree)

	1	2	3	4	5	N / A
They provide an alternative to congested "freeways"	<input type="radio"/>					
They have superior pavement condition	<input type="radio"/>					
T h e y a r e f a s t e r	<input type="radio"/>					
Toll rates are reasonable considering the benefits	<input type="radio"/>					
They are a safer alternative	<input type="radio"/>					
They provide more predictable travel time	<input type="radio"/>					
They provide an alternative in emergency situations	<input type="radio"/>					
We will use them when the shipper pays the toll	<input type="radio"/>					

Any other comments?

Thank You Page

Thank you so much for your participation!