Texas Department *of* Motor Vehicles

Memorandum

Date: 12/20/2018

To: Members of the Texas Legislature

From: Texas Department of Motor Vehicles and Texas Department of Public Safety

Subject: Studies Required by S.B. 2076, 85th Texas Legislature

The 85th Legislature passed Senate Bill (S.B.) 2076 by Rodriguez which included several updates regarding vehicle titling in Texas. In addition, the legislation required the Texas Department of Motor Vehicles (TxDMV) and the Texas Department of Public Safety (DPS) to study titling, registration and inspection processes, identifying any elements that could potentially be eliminated. These studies are to be submitted to the legislature prior to December 31, 2018. Following is the related language from S.B. 2076:

> *"Not later than December 31, 2018, the Department of Public Safety and the Texas Department of Motor Vehicles shall:*
>
> *(1) conduct a study on the efficiency and necessity of the titling, including actions related to titling such as registration, and inspection of vehicles in this state; and*
>
> *(2) submit to the legislature a report on the results of the study that includes:*
>
> *a. identification of any elements of the vehicle titling, including actions related to titling such as registration, and inspection programs that can be eliminated; and*
>
> *b. recommendations for legislation to eliminate those elements."*

Both departments independently pursued a competitive selection process to acquire the services of institutions of higher education to conduct these studies. TxDMV selected Texas State University (TXST) to study opportunities related to the titling and registration programs. DPS selected The University of Texas at Austin's Center for Transportation Research (CTR) to study opportunities related to the inspection program.

Enclosed please find both reports for your review and use. Should you have any questions or if we can provide any further clarifications or information, please do not hesitate to contact us as follows:

Texas Department of Motor Vehicles
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Government and Strategic Communications
512-465-4019
Caroline.Love@txdmv.gov

Texas Department of Public Safety
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Sincerely,

Whitney Brewster
Executive Director

Steven C. McCraw
Director

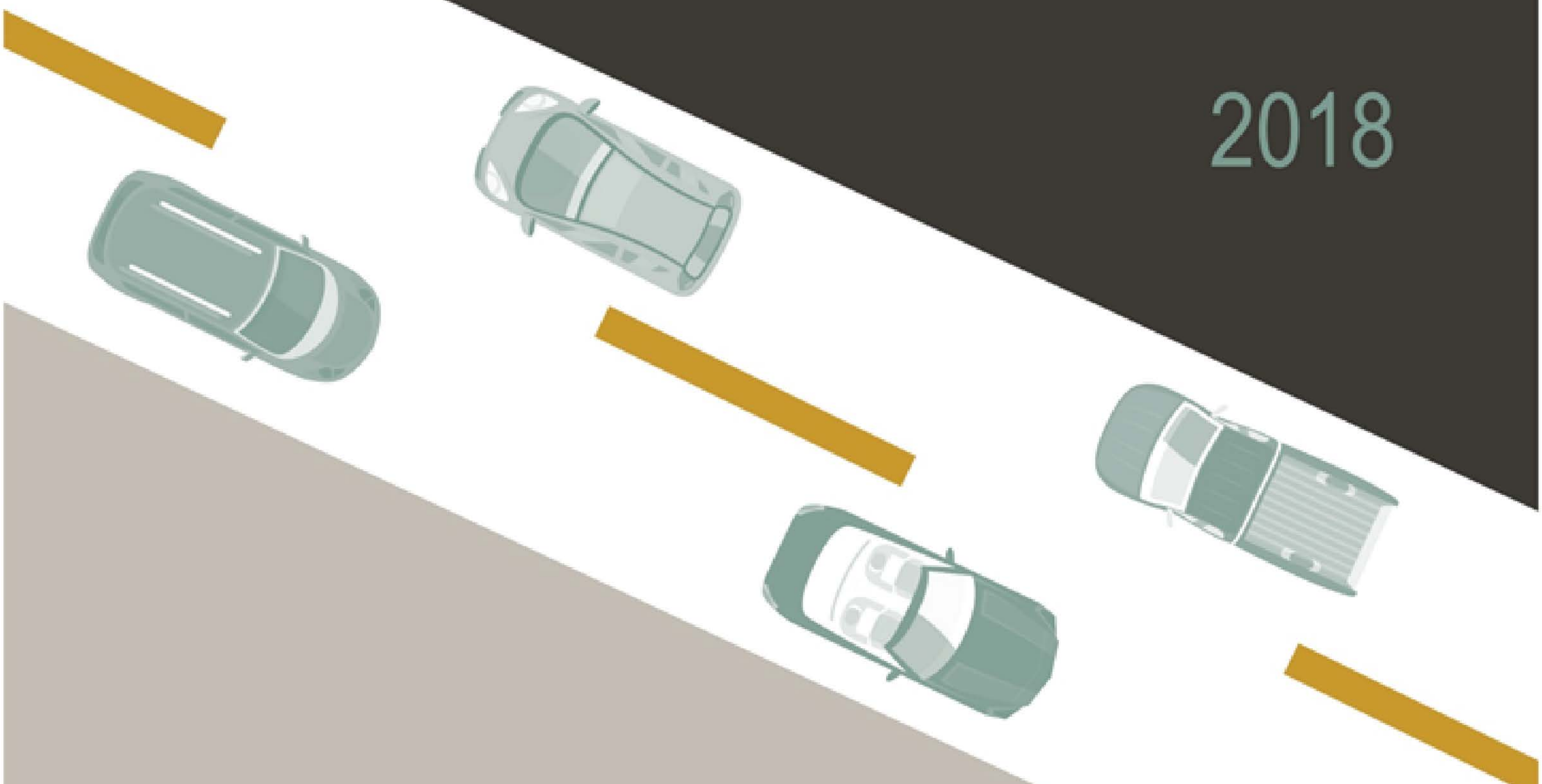
INTERIM STUDY

VEHICLE TITLE & REGISTRATION PROCESSES

TEXAS DEPARTMENT OF MOTOR VEHICLES

EXECUTIVE SUMMARY

2018



TEXAS STATE
INSTITUTE FOR GOVERNMENT INNOVATION

Vehicle Title and Registration Processes

Prepared by

Texas State University Institute for Government Innovation

Authors

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Julia Reeves

Prepared for

Texas Department of Motor Vehicles

Delivered on

December 20, 2018

This report was created by the Institute for Government Innovation at Texas State University under Statement of Work ##608-18-5663 with the Texas Department of Motor Vehicles. The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of Texas State University.

Executive Summary

Senate Bill (SB) 2076, enacted during the 85th Regular Session of the Texas Legislature, required the Texas Department of Motor Vehicles (TxDMV) and the Texas Department of Public Safety to “conduct a study on the efficiency and necessity of titling, including actions related to titling such as registration, and inspection of vehicles in this state…” SB 2076 required the TxDMV to submit a report to the legislature on the results of the study that includes any identified elements of vehicle titling and registration programs that could be eliminated and recommendations for legislation to eliminate those elements. The TxDMV contracted with Texas State University to complete the study and to produce a report on their findings and recommendations.

This study focused on titling and registration for non-commercial vehicles because passenger vehicles and light trucks make up more than 95 percent of the Texas vehicle population.

A mixed-methods approach was used to conduct the study. The methods, common to process improvement analysis, included: interviewing subject matter experts and stakeholders, benchmarking Texas’ practices with other states and countries, researching on the Internet, mapping high-level processes with flow charts, reviewing relevant literature, and estimating costs. For each cost estimate, current operational costs were compared to estimated future operational costs to calculate the potential operational cost savings. *Implementation costs were not a part of these cost estimates.*

One objective of the study was to determine the necessity of titling vehicles in Texas. A certificate of title, or more commonly, “title,” is a document used in the United States to indicate legal ownership of a vehicle. The purpose of a title is to assist in preventing vehicle theft and the improper transfer of vehicles with a lien. Titles also help prevent fraud by documenting the mileage at the time of sale and any value-limiting remarks. Vehicle titles are necessary for the prevention of vehicle theft, improper transfer of vehicles, and fraud.

The study further evaluated whether any elements of vehicle titling, including vehicle registration, could be eliminated.

While vehicle titles deter theft and fraud, vehicle registration enables the State of Texas, and its 254 counties, to collect fees from vehicle owners who use Texas roads and bridges. Registration funds are used to maintain and upgrade the local and state transportation network and help ensure roadways are safe.

Evaluations performed for this study indicated there is a necessity for vehicle titling and registration. Analysis also revealed the potential to improve elements of the titling and registration processes by eliminating inefficient steps. These process improvements were recommended to reduce fraud, eliminate redundancies, enhance customer convenience, and reduce operational costs for the TxDMV, which administers vehicle titling and registration in Texas.

The remainder of this summary addresses vehicle titling and registration separately.

Vehicle Titling

Vehicle titling establishes vehicle ownership and, in turn, enables the transfer of that ownership. The typical title transaction involves a change in vehicle ownership. The study focused on these transactions.

Historically, titles have been a physical paper document, though keeping track of a paper title can be problematic, and a paper title presents opportunities for fraud. Title fraud occurs in many ways, but one way is to alter the paper document, changing the owner's name, or removing a lien or value-limiting brand. The economic impact of title fraud is difficult to quantify, but it has been estimated to be in the billions of dollars annually in the US[1].

Texas was one of the first states to use electronic titles, implementing them in 2009 through the TxDMV's Electronic Lien and Title (ELT) Program. Participating lienholders receive electronic titles, which eliminates the requirement for TxDMV to print and mail titles to lienholders who must then maintain them.

Texas created the nation's first fully electronic title program, webDEALER, in 2013. The TxDMV's webDEALER allows participating automobile dealerships to make application for title electronically to county tax assessor-collector offices. The electronic submission of title applications was extended to salvage and insurance stakeholders in 2016 through the implementation of TxDMV's webSALVAGE application.

The TxDMV is scheduled to implement the transfer of electronic titles in the wholesale market within webDEALER in 2019. Lienholders will also receive the ability to submit title applications electronically with the implementation of the TxDMV's webLIEN application. The TxDMV's webLIEN is a precursor to allowing individuals in a private party sale to transfer a title electronically. Private party transfers in Texas currently require the buyer to take the paper title to a county tax assessor-collector office to officially document the change of vehicle ownership.

Texas could eliminate paper titles used in private party transfers by offering an online electronic title system to process some of these transactions. With the passage of the Fixing America's Surface Transportation Act in 2015, statute no longer prohibits the development of such a system. The Arizona Department of Transportation (ADOT) successfully developed an online system to process

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private party vehicle transfers electronically, which was implemented in April 2018. Offering electronic titling for private party title transfers would help TxDMV move towards their goal of reducing fraud by offering electronic titling for all vehicle title transfers. The elimination of paper titles has the additional potential to create long-term operational efficiencies for TxDMV and make transactions more convenient for customers.

Development of a system to facilitate private party transfers is more complicated and expensive than the existing electronic title systems for dealers and lienholders because private party transfers require individual, unique identity validation for both the buyer and seller prior to transfer. The operational cost savings of eliminating paper titles is relatively small, at approximately $77,000 annually. The long-term savings, however, could be more significant if half the private party transfers used electronic titles, as processing costs may be able to be reduced after implementation. Eliminating paper titles can also help reduce the broader economic losses of title fraud. There is benefit in the TxDMV continuing the expansion of its electronic titling systems.

Vehicle Registration

Vehicle registration enables the State of Texas and its 254 counties to collect fees from users of Texas roads and bridges to maintain the transportation network and help ensure roadway safety. While the first time a vehicle is registered is in conjunction with the initial title transaction, vehicle registration is most commonly processed through annual vehicle registration renewals. The issuance of a title and initial registration creates an ongoing operational expense to notify customers of renewal date, process those renewals, and credential vehicles. Changes can be made at the time of title and initial registration to reduce or eliminate the need for ongoing operational expenses. The ongoing operational expenses related to the vehicle registration renewal process include:

1. *Notifying* the customer of their expiring vehicle registration;
2. *Processing* the customer's vehicle registration request either in-person, by mail, or online after verifying inspection and insurance; and

3. *Credentialing* the customer's vehicle by providing a registration sticker either in-person or through the mail.

Through this study, the potential to eliminate aspects of all three steps were identified.

Each of the three major registration steps studied—notifying, processing, and credentialing—were addressed separately in the full study and the remainder of this summary.

Registration Notifications

Throughout the United States (US), states use various methods to notify vehicle owners their vehicle registration will expire if not renewed. In Texas, customers receive a vehicle registration renewal notice by mail and may also opt-in to receive an email reminder. Unlike the mailed renewal notice, the email reminder is only intended to remind people to renew and does not provide the customer an invoice to renew.

The TxDMV has plans to implement an email renewal notice, which would provide the customer an invoice to renew. However, email alone may not be a sufficient notification method. Researchers at the University of Notre Dame and Indiana University found when University students received a text message, voter registration increased over an email message[2]. This corroborated findings by researchers at Ludwig-Maximillian University in Munich who found that response rates increased when text messages encouraging the use of coupons were sent[3]. For a variety of reasons—including change of internet service provider, multiple

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email accounts, and spam filters—not all emails reach their intended audience. One study estimated 20% of emails are opened and 80% of text messages are opened[4].

By offering text message renewal notices in conjunction with email notifications, the TxDMV can ensure they are doing as much as possible to minimize late vehicle registration and reduce costs. TxDMV spends $0.4733 per mailed notice and incurs minimal costs to send the emailed reminder. By offering an option for electronic notifications, TxDMV can also require customers who choose to be notified electronically to stop receiving mailed renewal notices, thus eliminating some mailed renewal notices. Elimination of mailed renewal notices would reduce the cost to the state by $0.4733 for each customer who elected to be notified electronically.

Nothing in existing statute prohibits the development of such a process. Currently, 18.5% of customers have requested email reminders. TxDMV could save $1.9 million in annual operations costs based upon an assumed 18.5% adoption rate for text or email renewal notices. The savings would increase as more customers elected to be notified by text message. A text message notification option will require additional programming at an unknown cost and require the collection of both an email and phone number from participating customers.

Registration Processing

Vehicle registration renewal is accomplished through various methods, depending on the state, such as in-person, by mail, and online. Forty-eight states allow a customer to renew their registration online, including Texas. Looking outside of the US, the United Kingdom (UK) allows the automatic payment of vehicle registration fees annually and even allows customers to change from annual payments to

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semi-annual or monthly payments[5]. Australian states allow automatic registration payments in three, six, and 12-month increments. According to a 2017 survey, this type of automatic renewal or subscription service was used by 79% of survey respondents[6], in part because automatic subscription services are convenient for the customer. Nothing in existing statute prohibits the development of an automatic registration renewal capability in Texas.

The adoption rate of customers converting from an in-person or mail-in renewal to an online renewal could be a predictor of the adoption rate for automatic registration renewal (auto-renewal). Historically, the adoption rate of customers choosing online registration renewal over in-person or mail renewal has been slowly growing. However, the rate of customers renewing online has plateaued at around 20%. Customers incorrectly assume online registration renewal is costly. Customers with registration about to expire or already expired are not aware their online registration receipt is proof of registration for 30 days. Customers requesting auto-renewal could enroll at any point in the registration year either online or in-person at the county tax assessor-collector office.

There would be an expense to develop and implement auto-renewal capability and an ongoing operating expense to operate and maintain option. However, every in-person renewal customer who converts to an auto-renewal customer would save TxDMV $2.4695 annually in ongoing operating expense. If 5% of in-person customers converted, it is estimated TxDMV could save $1.8 million annually.

Development of an auto-renewal capability would come with assumed additional benefits as adoption rates increase: late registration renewals would be reduced; lines at vehicle registration renewal locations would be alleviated; and customer convenience would be increased. Although it is not a formal recommendation of

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this study, an auto-renewal capability could enable customers to prepay their annual registration in installments to reduce the financial strain caused by the lump-sum payment. It is recommended that TxDMV develop and implement an auto-renewal option.

Registration Stickers

Across the US, there are two common types of credentials issued to vehicle owners to visibly indicate payment of registration fees. The most common method is a license plate sticker. A license plate sticker is usually placed on the license plate. Texas is one of two states in the US that use a windshield registration sticker for vehicles with a windshield; vehicles without a windshield receive a license plate sticker. The Texas registration sticker indicates both inspection and registration requirements have been met. Some states use an inspection sticker in the same way Texas uses the registration sticker.

Looking outside of the US, Quebec, Canada has not had any external indication of registration payment for more than 30 years. Quebec discontinued the use of stickers to indicate vehicle registration in the 1990s and does not require annual vehicle inspections for most vehicles. In 2014, the UK discontinued registration stickers. Australia also discontinued the use of registration stickers, providing law enforcement instant access to vehicle registration records, and encouraging compliance by enforcing registration payments through heavy fines and penalties for driving without payment.

As an enforcement technology, registration stickers lack visibility. The registration sticker can be difficult to view when travelling in the same direction or opposite direction. The placement or size of the registration stickers, the distance between two vehicles, and the speed of the two vehicles can make it difficult to read the stickers. Furthermore, during low light conditions, the stickers are frequently unreadable.

The proliferation of new technologies, such as automatic license plate readers, and the availability of vehicle registration data to law enforcement via the Texas Law Enforcement Telecommunications System (TLETS) render the registration sticker obsolete as a means to validate current registration In the event of a traffic stop where law enforcement is unable to verify current registration via TLETS, the registration receipt could act as the driver's proof of valid registration.

A change to statute would be required to implement a recommendation to eliminate the display of a current registration sticker when operating a vehicle on public roads. Estimates of the potential cost savings from discontinuing windshield registration stickers are based on current costs of producing and distributing windshield stickers. It is estimated the TxDMV could save approximately $5.4 million annually in operational costs by discontinuing the use of windshield stickers. It is recommended the TxDMV eliminate the registration sticker.

Conclusion

In conclusion, the study identified the importance and necessity of vehicle titling and registration. The study also identified four recommendations to eliminate some elements of vehicle titling and registration processes to improve efficiency:

1. Eliminate the need for some paper vehicle titles by offering electronic private party title transfers.
2. Eliminate some mailed renewal notices by offering text message and email renewal notices.
3. Eliminate some in-person customers for vehicle registration renewal by offering automatic vehicle registration renewal (auto-renewal) payments.
4. Eliminate the registration sticker.

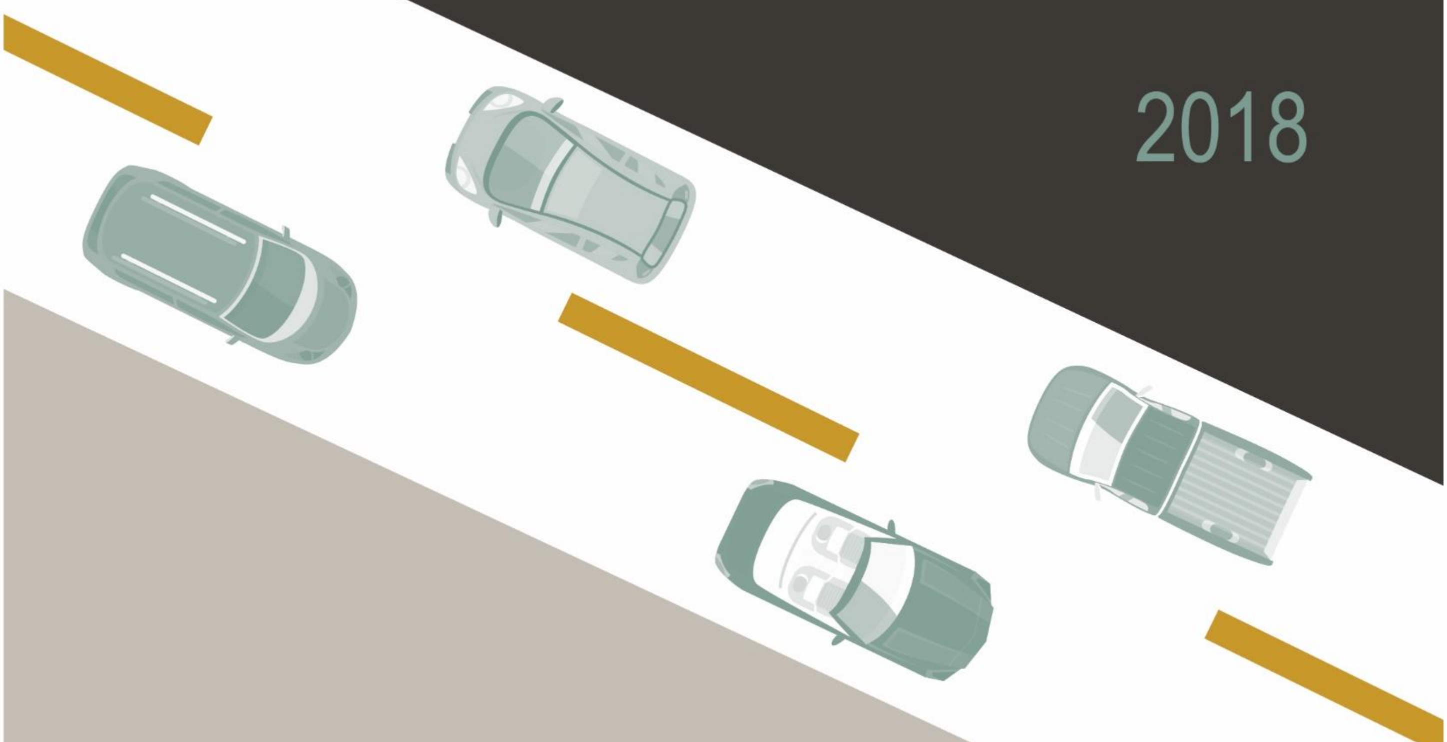
These recommendations are intended to create operational efficiencies for TxDMV and make the processes more efficient for customers. If all four recommendations were implemented, it was estimated TxDMV could save approximately $9.1 million in operational costs annually.

INTERIM STUDY

VEHICLE TITLE & REGISTRATION PROCESSES

TEXAS DEPARTMENT OF MOTOR VEHICLES

2018



TEXAS STATE
INSTITUTE FOR
GOVERNMENT INNOVATION

December 20, 2018

Dear Honorable Members of the Legislature:

The Texas Department of Motor Vehicles (TxDMV) is charged by SB 2076, 85th Legislature with studying titling and registration processes to identify elements of those processes that can be streamlined or eliminated. TxDMV partnered with Texas State's (TXST) *Institute for Government Innovation* to conduct the study. A copy of TXST's report is enclosed with this correspondence.

TXST is providing four recommendations for the Legislature and TxDMV to consider. As noted on page three of their report, "Implementation costs were not a part of these cost estimates." TxDMV believes that Texas State's recommendations require additional research to further estimate the true costs of implementation.

Moreover, while TxDMV appreciates the benefits of the recommendations developed, the impact on key stakeholder groups must be vetted thoroughly to ensure the smooth implementation of any recommendation. As some recommendations impact a wide range of stakeholders, business partners and TxDMV customers, TxDMV strongly encourages more dialogue with all those impacted, including the Legislature, to ensure all possible advantages, disadvantages and consequences are fully and thoroughly explored. This is especially true for those recommendations which can have an impact on funding and potential changes in process responsibilities.

I wish to convey my appreciation to the staff at TXST for their hard work and commitment to providing a fair, objective review of Texas' vehicle title and registration processes. I look forward to working with the 86th Legislature when it considers these and any other recommendations to help improve the services provided to Texans.

Sincerely,

Whitney H Brewster

Whitney H. Brewster
Executive Director

Enclosure

Vehicle Title and Registration Processes

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Registration Stickers

Across the US, there are two common types of credentials issued to vehicle owners to visibly indicate payment of registration fees. The most common method is a license plate sticker. A license plate sticker is usually placed on the license plate. Texas is one of two states in the US that use a windshield registration sticker for vehicles with a windshield; vehicles without a windshield receive a license plate sticker. The Texas registration sticker indicates both inspection and registration requirements have been met. Some states use an inspection sticker in the same way Texas uses the registration sticker.

Looking outside of the US, Quebec, Canada has not had any external indication of registration payment for more than 30 years. Quebec discontinued the use of stickers to indicate vehicle registration in the 1990s and does not require annual vehicle inspections for most vehicles. In 2014, the UK discontinued registration stickers. Australia also discontinued the use of registration stickers, providing law enforcement instant access to vehicle registration records, and encouraging compliance by enforcing registration payments through heavy fines and penalties for driving without payment.

As an enforcement technology, registration stickers lack visibility. The registration sticker can be difficult to view when travelling in the same direction or opposite direction. The placement or size of the registration stickers, the distance between two vehicles, and the speed of the two vehicles can make it difficult to read the stickers. Furthermore, during low light conditions, the stickers are frequently unreadable.

The proliferation of new technologies, such as automatic license plate readers, and the availability of vehicle registration data to law enforcement via the Texas Law Enforcement Telecommunications System (TLETS) render the registration sticker obsolete as a means to validate current registration In the event of a traffic stop where law enforcement is unable to verify current registration via TLETS, the registration receipt could act as the driver's proof of valid registration.

A change to statute would be required to implement a recommendation to eliminate the display of a current registration sticker when operating a vehicle on public roads. Estimates of the potential cost savings from discontinuing windshield registration stickers are based on current costs of producing and distributing windshield stickers. It is estimated the TxDMV could save approximately $5.4 million annually in operational costs by discontinuing the use of windshield stickers. It is recommended the TxDMV eliminate the registration sticker.

Conclusion

In conclusion, the study identified the importance and necessity of vehicle titling and registration. The study also identified four recommendations to eliminate some elements of vehicle titling and registration processes to improve efficiency:

1. Eliminate the need for some paper vehicle titles by offering electronic private party title transfers.
2. Eliminate some mailed renewal notices by offering text message and email renewal notices.
3. Eliminate some in-person customers for vehicle registration renewal by offering automatic vehicle registration renewal (auto-renewal) payments.
4. Eliminate the registration sticker.

These recommendations are intended to create operational efficiencies for TxDMV and make the processes more efficient for customers. If all four recommendations were implemented, it was estimated TxDMV could save approximately $9.1 million in operational costs annually.

Introduction

Senate Bill (SB) 2076, enacted during the 85th Regular Session of the Texas Legislature, required the Texas Department of Motor Vehicles (TxDMV) and the Texas Department of Public Safety (DPS) to "conduct a study on the efficiency and necessity of titling, including actions related to titling such as registration, and inspection of vehicles in this state…" SB 2076 required the TxDMV to submit a report to the legislature on the results of the study that includes any identified elements of vehicle titling and registration programs that could be eliminated and recommendations for legislation to eliminate those elements. The TxDMV contracted with Texas State University to complete the study and to produce a report on their findings and recommendations.

The TxDMV is responsible for titling and registering motor vehicles in the State of Texas. In FY 2018, the TxDMV processed 7,983,315 titles and registered 24,880,151 vehicles, generating approximately $1.5 billion in fees.

This study focused on titling and registration for non-commercial vehicles because passenger vehicles and light trucks make up more than 95 percent of the Texas vehicle population.

It is important to begin by understanding the purpose of vehicle titles. Vehicle titling establishes vehicle ownership. The purpose of titling vehicles, according to Texas law, is to lessen and prevent:

1. The theft of motor vehicles;
2. The importation into this state of and traffic in motor vehicles that are stolen; and
3. The sale of an encumbered motor vehicle without the enforced disclosure to the purchaser of a lien secured by the vehicle.

The State of Texas and its 254 counties collect fees from users of Texas roads and bridges through vehicle registration to maintain and upgrade the transportation network and ensure public safety. While the first time a vehicle is registered is typically in conjunction with the initial title transaction, vehicle registration is most commonly processed through annual vehicle registration renewals.

Evaluations performed for this study indicate the importance of vehicle titling and registration to the State and vehicle owners. Analysis did, however, reveal some elements within the titling and registration processes which could be eliminated. Due to the volume of titling and registration transactions performed annually in Texas, even minor improvements could have a broad impact on vehicle owners and operators in Texas.

The study identified recommendations to eliminate one element of the vehicle titling process and three elements of the vehicle registration process.

- Eliminate the need for some paper vehicle titles by offering electronic private party title transfers.
- Eliminate some mailed renewal notices by offering email notifications with text message reminders, in lieu of mailed renewal notices.
- Eliminate the need to serve some customers in person by offering automatic vehicle registration renewal (auto-renewal) payments.
- Eliminate the vehicle registration sticker.

These recommendations offer the potential to reduce fraud, reduce wait times for in-office transactions, enhance customer choice and convenience, increase compliance, and reduce operational costs for the TxDMV. In total, these changes are estimated to save the TxDMV approximately $9.1 million per year.

Details and analysis regarding these recommendations can be found in the Titles and Registration Sections of this report. The Registration Section is further divided into Registration Notification, Registration Processing, and Registration Sticker.

Methods

A mixed-methods approach was used to conduct the study. The methods, common to process improvement analysis, included: interviewing subject matter experts and stakeholders, benchmarking Texas' practices with other states and other countries, researching on the Internet, mapping high-level processes with flow charts, reviewing existing research, and estimating costs.

For each cost estimate, current operational costs were compared to estimated future operational costs to calculate the potential operational cost savings. *Implementation costs were not a part of these cost estimates.*

Our interviewees were vehicle title and registration subject matter experts, stakeholders representing county and state governments, and state and international trade associations. Some of the experts interviewed were recommended by the TxDMV; others were identified through benchmarking or internet research. For example, it was important to interview a county tax assessor-collector because of the role of county tax assessor-collectors in processing most of the vehicle title and registration transactions in the State. The TxDMV recommended we interview the Nueces County Tax Assessor-Collector due to his role as designated liaison of the Tax Assessor-Collectors Association of Texas to the TxDMV. For a complete list of interviews, see Appendix 1: Interviews.

Benchmarking information was collected on select vehicle title and registration practices in all 50 states. A database of state's practices was created to later query and analyze. For tables summarizing other states' titling and registration notification, processing, and credential methods, please see Appendix 2: Benchmarking Results.

Vehicle Titles

The first objective of the study was to determine the necessity of titling vehicles in Texas. A certificate of title, or more commonly, “title,” is a document used in the United States to indicate legal ownership of a vehicle.

Vehicle titles have been issued in Texas since 1939. The three primary purposes a title serves are outlined in Texas Transportation Code, Sec. 501.003. According to law, the purpose of vehicle titles in Texas are “to lessen and prevent:

1. The theft of motor vehicles;
2. The importation into this state of and traffic in motor vehicles that are stolen; and
3. The sale of an encumbered motor vehicle without the enforced disclosure to the purchaser of a lien secured by the vehicle.”

A title includes a variety of information to accurately identify a vehicle including the vehicle identification number or VIN, the make, model, year of manufacture, and weight. The Federal Truth in Mileage Act (TIMA) requires an odometer disclosure at the time of vehicle sale. A title may also include value-limiting brands, such as “Flood Damage” or “Rebuilt Salvage-Damaged”, which indicates the vehicle sustained major damage. This type of value-limiting brand alerts potential buyers that the value of the vehicle is limited. Vehicle titles are necessary for the prevention of vehicle theft, improper transfer of vehicles, and fraud.

The study further evaluated whether any elements of vehicle titling, including vehicle registration, could be eliminated.

Title transactions can be grouped into two broad categories: 1) title transactions that include a change of ownership and 2) title transactions that do not include a change of ownership, such as when a lien is added or removed. The typical title transaction involves a change of ownership.

In FY 2018, 6,432,879 vehicle titles were processed in Texas to transfer vehicle ownership. Of those vehicles with a transfer of ownership, 63% were purchased from dealers licensed in Texas, including both new and used cars sales. The remaining 37% of vehicles transferred in Texas that year were private party transfers not involving a dealer (Figure 1).

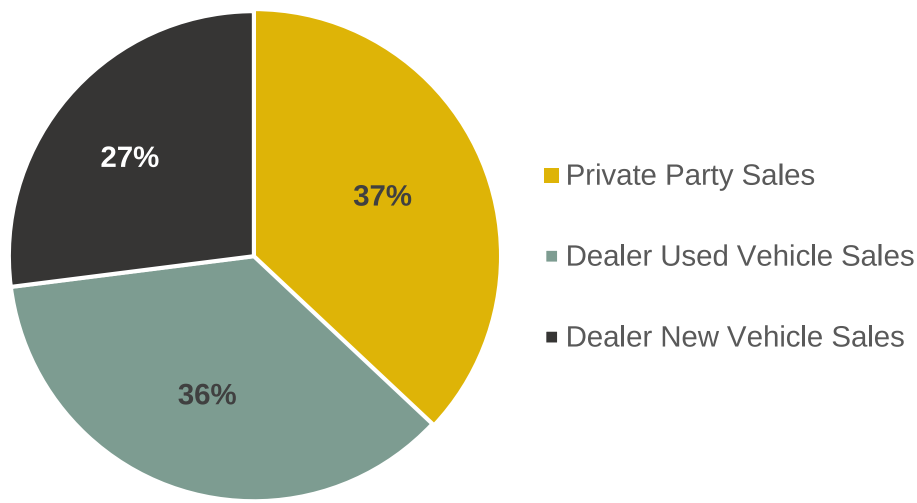

Figure 1. Percentage of private party, dealer used, and dealer new vehicle sales

Texas was one of the first states to use electronic titles, implementing them in 2009 through the TxDMV's Electronic Lien and Title (ELT) Program. Participating lienholders receive electronic titles, which eliminates the requirement for TxDMV to print and mail titles to lienholders who must then maintain them.

Texas created the nation's first fully electronic title program, webDEALER, in 2013. The TxDMV's webDEALER application allows participating automobile dealerships to make application for title electronically to county tax assessor-collector offices. The electronic submission of title applications was extended to salvage and insurance stakeholders in 2016 through the implementation of the TxDMV's webSALVAGE application. The TxDMV is scheduled to implement the transfer of electronic titles in the wholesale market within webDEALER in 2019.

Lienholders will also receive the ability to submit title applications electronically with the implementation of the TxDMV's webLIEN application. The TxDMV's webLIEN application is a precursor to allowing individuals in a private party sale to transfer a title electronically. Private party transfers in Texas currently require the buyer to take the paper title to a county tax assessor-collector office to officially document the change of vehicle ownership.

Given the enhancements to vehicle titling available to lienholders and vehicle dealers, the remainder of the study focused on private party title transfers to identify potential elements of the title process which could be eliminated.

A variety of research methods were used to identify opportunities to eliminate key elements of the title processes that involve a change in ownership. Interviews, benchmarking, internet research, and process maps led to recommendations to eliminate unnecessary elements of the current title processes. Calculations confirmed the potential for cost savings.

In total, experts at five entities were interviewed as part of the effort to identify efficiencies in the vehicle title process. These subject matter experts were from the TxDMV, the American Association of Motor Vehicle Administrators, the Nueces County Tax Assessor-Collector's Office, Arizona Department of Transportation, and the Texas Department of Information Resources. For the complete list of individuals interviewed, see Appendix 1: Interviews, and for benchmarking results, see Appendix 2: Benchmarking Results.

This research concluded with the recommendation to eliminate the need for some paper vehicle titles by offering electronic private party title transfers.

Vehicle Title Transfers in Texas

Historically, titles have been a physical paper document. Keeping track of a paper title can be problematic, and a paper title presents opportunities for fraud. Title fraud occurs in many ways, but one way is to alter the paper document, changing the owner's name, or removing a lien or value-limiting brand. Approximately 1.6 million (6%) of the Texas titles issued by county tax assessor-collectors in FY 2018 had a value-limiting brand such as "Rebuilt Salvage-Damaged" or "Flood Damage". These brands limit the value of the vehicle and subject the buyer to fraud if they are unaware of them prior to purchase.

If the original title is lost, a Certified Copy of Texas Title (CCO) must be obtained prior to title transfer. The TxDMV Regional Service Centers issued more than 400,000 CCOs in FY 2018. Paper titles, especially CCOs, can contribute to fraud, in part because it is currently possible for two paper titles to exist for the same vehicle. On December 31, 2018, the TxDMV will eliminate this risk by implementing the provision in SB 2076 that specifies a lawfully-obtained CCO supersedes and invalidates any previously issued Texas title or CCO. There will only be one valid ownership document per vehicle as a result. Additionally, paper titles can lead to data entry errors, especially when entering the 17-digit VIN. These errors necessitate corrections, which result in inconvenience for customers, the county tax assessor-collectors, and the TxDMV.

These paper titles are used even though the official record of ownership for all vehicles in Texas is the TxDMV's motor vehicle database. Texas is a participant in the National Motor Vehicle Title Information System (NMVTIS), a nationwide database developed to help reduce vehicle fraud which includes title information for 95% of US vehicles.

Paper titles are used in private party transfers currently. The typical private party transfer in Texas involves three major steps:

1. Seller signs paper title document, obtaining a CCO, if required.
2. Buyer takes the signed paper title and application to a county tax assessor-collector's office.
3. County tax assessor-collector's office reviews the documentation and enters the title transaction data in the State's motor vehicle database.

In addition to signing the title, the *seller* should also submit a Texas Motor Vehicle Transfer Notification form to the TxDMV to protect themselves from tickets or toll fines if the buyer fails to process the title transfer in a timely fashion. To protect themselves from potential problems, the *buyer* should complete a title check via an authorized third-party provider to ensure the vehicle title does not have value-limiting brands prior to purchasing the vehicle. Frequently, these steps do not occur.

A flow chart of the private party title transfer process reveals the many parties and steps required to successfully transfer vehicle ownership (Figure 2).

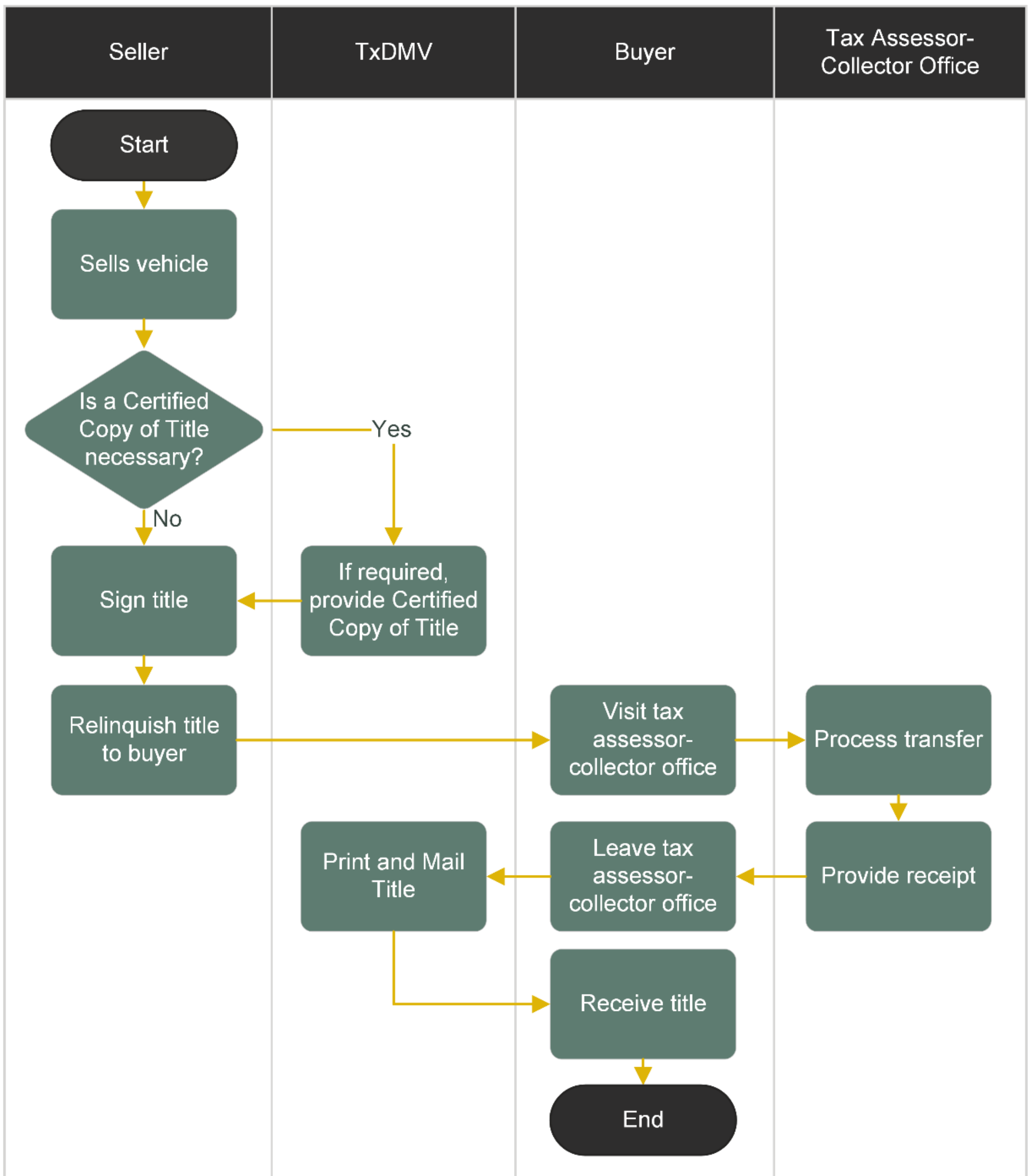

Figure 2. Current private party title transfer flowchart

Vehicle Title Transfers in Other Jurisdictions

Generally, states around the nation share the same practices when it comes to private party transfers. However, there are some states that deviate from the standard practice.

Almost all states allow individual vehicle owners to process their private party title transfer at the jurisdiction's appropriate office. The exception to this rule is the State of Rhode Island which does not allow in-person title transfers, instead only processing title transfers through the mail. Twelve of the benchmarked states offer a mail-in title transfer where both parties involved in the transfer mail their documents to the appropriate entity to process their transfer. The State of Wisconsin offers a hybrid method to transfer titles. Their hybrid method uses a combination of personal online data entry and mail to complete a title transfer transaction.

Most notably, the Arizona Department of Transportation (ADOT) successfully developed an online system to process private party vehicle transfers electronically, which was implemented in April 2018. They refer to their process as eTitle.

ADOT has several requirements for the seller, the buyer, and the vehicle record to qualify for use of the eTitle process, including:

- Buyer and seller are both required to create a customer account and place a picture on file.
- Buyer and seller are both required to be the sole owners.
- Buyer and seller are required to complete the transaction in a timely manner.
- Buyer must agree to receive an eTitle.
- Vehicle must be a non-commercial, passenger vehicle.
- Vehicle cannot have any liens or title brands.

- Vehicle registration and inspections must be current.

The steps required for both the buyer and seller to use Arizona eTitle transfer process are illustrated on their website (Figure 3).

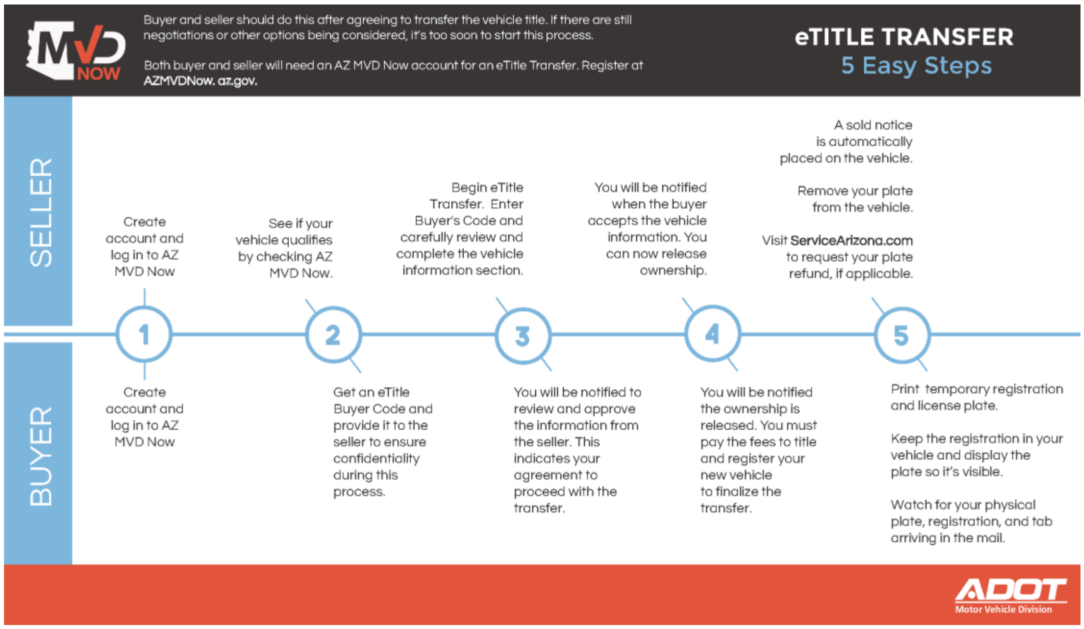

Figure 3. Arizona eTitle process (screenshot)

While the process may appear to have a similar level of complexity to the Texas process map, two important differences distinguish it from the current process. First, the seller is not required to present a paper title because the official electronic record of vehicle ownership contained in the motor vehicle database is used as the basis for transfer. Second, both the buyer and seller participate in the transfer process with minimal assistance from government employees.

Paper Titles and eTitles

After identifying the potential to eliminate paper titles through an electronic private party transfer system, the procedural differences, potential cost savings, necessity of statute or rule changes, and general pros and cons were examined.

Procedural Differences

Based on Arizona's online title transfer process, a future process map was developed (Figure 4).

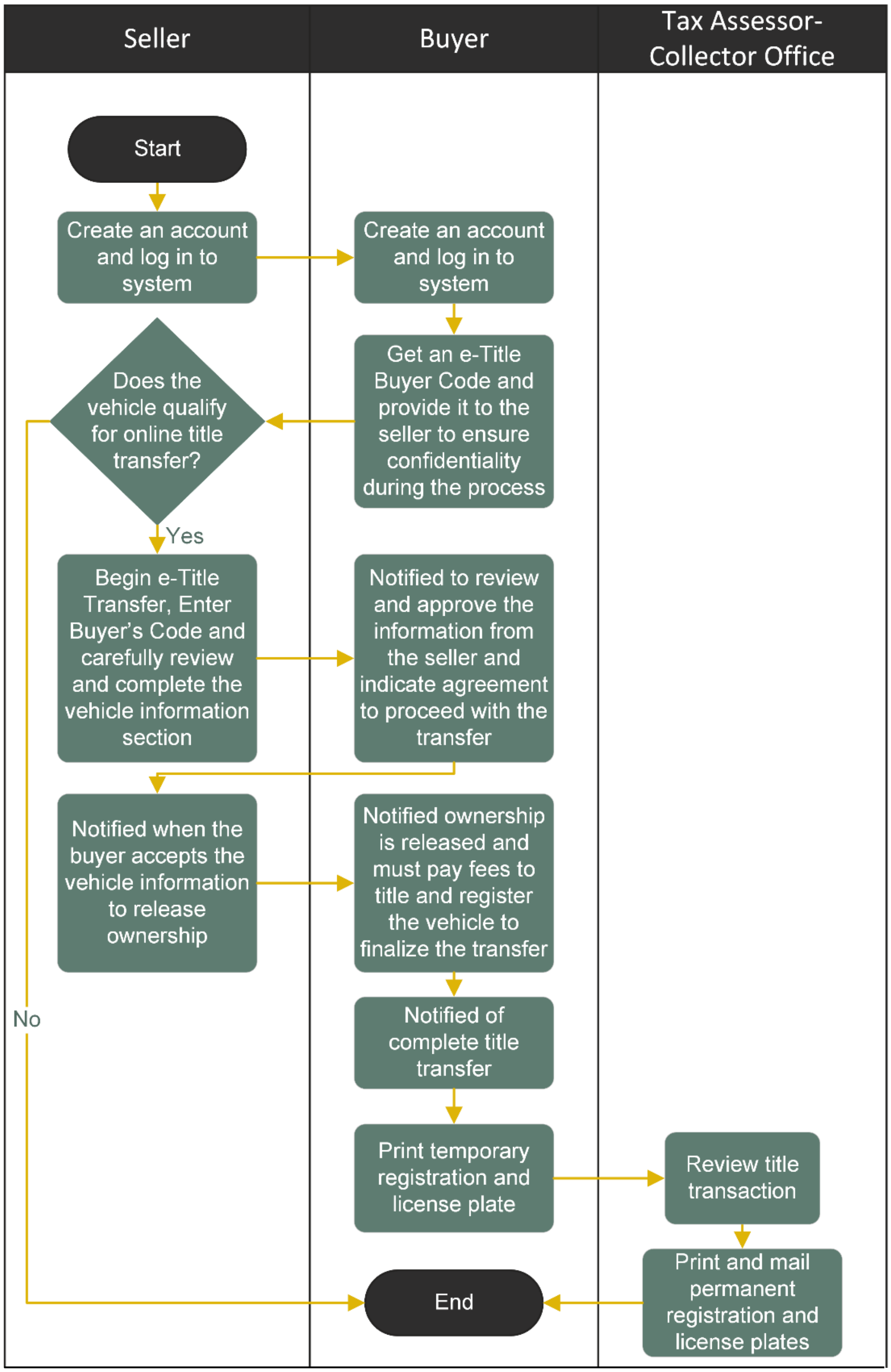

Figure 4. Future private party title transfers flowchart based on Arizona Department of Transportation

There are several critical facts to consider when developing an electronic title transfer process. It will be important to verify the identity of both the buyer and seller online before the title transfer begins and verify the vehicle has current insurance and inspection and is otherwise eligible to use the electronic title process. The transfer process will then need to validate the owner's authority to transfer ownership and the buyer's willingness to accept vehicle ownership. Upon completion of the transfer process, the State's motor vehicle database will be updated.

Additionally, a user account system would need to be created where owners could have access to their electronic title to transfer it. The creation of these accounts and a system to manage them would be a significant investment of time and money. The TxDMV should work to partner with other state agencies because of the many benefits these accounts could offer a variety of agencies and purposes.

Strategic Business Partner Processes

Implementing an electronic title capability for private party transfers in Texas does not require changes to the operating authority of any of the entities involved in processing these title transfers. However, as the popularity of electronic private party title transfers grows, county tax assessor-collectors will likely experience a reduction of in-office title transfers. The TxDMV Regional Services Centers should similarly experience a reduced demand for CCOs. Furthermore, a process to review and audit electronic title transfers would need to be established. This process would likely involve existing strategic business partners.

Although Arizona developed their entire private party title transfer system in-house, Texas may need to partner with a third party to facilitate creation of a user account to validate vehicle sellers' and buyers' identities. Development of an electronic platform to facilitate private party transfers is feasible in Texas, according to the Texas Department of Information Resources.

Operational Cost Savings

To explore the potential operational cost savings of changes to the title process, a cost estimate was developed. In FY 2018, there were 2,380,165 private party transfers. This assumes every private party transfer resulted in a paper title being issued. It is possible an electronic title was issued if the buyer financed the vehicle through an ELT lienholder. This is likely a very small number of the private party transfers though. The TxDMV spent an estimated $154,711 on paper to print titles for private party transfers (Table 1).

Table 1. Estimated current private party title paper costs

Transaction Method	Estimated Number of Customers	Title Paper Cost per Customer	Total Title Paper Cost for Private Party Transfers
Paper title transfer	2,380,165	$0.065	$154,711
			$154,711

If 50% of these private party transfers used electronic titles, and therefore received an electronic title instead of a paper title after their electronic title transfer, $77,355 would be saved. These savings represent only the cost to purchase the special paper used to print titles involved directly in private party transfers. It does include the cost of title paper used for CCOs required to complete some private party transfers. While the initial cost savings estimates are small, development of an electronic title system for private party title transfers in Texas moves the TxDMV towards their goal of fully implementing electronic titles to reduce fraud and protect consumers.

Changes to Existing Statutes and Rules

With the passage of the Fixing America's Surface Transportation Act in 2015, statute no longer prohibits the development of an electronic titling system. A review of Texas statutes indicates there is nothing that needs to be changed to implement this recommendation.

Some changes to 43 Texas Administrative Code Chapter 217, Subchapter A, Motor Vehicle Titles, will be required to implement an electronic private party transfer capability in Texas.

Advantages and Disadvantages

The advantages and disadvantages of implementing an electronic private party vehicle title transfer system were considered before finalizing a recommendation.

ADVANTAGES

Transferring titles for private party vehicle sales electronically provides several time and cost efficiencies for all the parties involved in the transaction.

In general, the system will reduce operational costs by approximately $154,711 annually.

- The *buyer* does not need to visit their county tax assessor-collector's office, yet they retain the assurance of knowing they are buying a vehicle without title problems. The buyer could be further protected if an option to purchase a third-party title check was built into the software.

- The *seller* is assured the title is transferred out of their name, thereby avoiding the hassle of the buyer racking up tickets or toll fines before transferring the title into their name.

- *County tax assessor-collectors* benefit by a reduction in the volume of title transfer customers visiting their offices.

- The *TxDMV* Regional Service Centers traffic should be reduced because fewer customers will need CCOs. The TxDMV also benefits because the potential for title fraud is reduced, increasing the integrity of the State's motor vehicle database. Further, the TxDMV benefits because their title paper costs can be reduced by approximately $77,000 annually.

DISADVANTAGES

Electronic titles cannot be used for all transactions. Vehicle owners will still need a paper title if they are moving out-of-state. There will also still be paper titles coming in from out-of-state. Heirship title transfers and other more complicated transfers can't be accommodated either. If the original paper title for a vehicle sold in an electronic title transfer is not destroyed, it could be used to commit fraud.

Vehicle Title Recommendation

In summary, research revealed 37% of vehicle title transfers occur via private party transactions. These title transfers with a change of ownership cannot be completed with an electronic title.

Benchmarking has revealed that an electronic title transfer process for private party transfers has been developed in Arizona.

Development of an electronic title transfer process will significantly improve the efficiency of the TxDMV, help protect consumers by reducing fraud, and produce some cost-savings.

Development of a system to facilitate private party transfers is more complicated and expensive than the existing electronic title systems for dealers and lienholders because private party transfers require identity validation for both the buyer and seller prior to transfer. The operational cost savings of eliminating paper titles is relatively small, at approximately $77,000 annually; however, the long-term savings could be more significant if half the private party transfers used electronic titles, as processing costs may be able to be reduced after implementation. Eliminating paper titles can also help reduce the broader economic losses associated with title fraud. There is benefit in the TxDMV continuing the expansion of its electronic titling systems, too. Given the operational cost savings created by this recommendation and the supporting example of ADOT, it is recommended that the TxDMV implement electronic titles for private party transfers, thereby eliminating the need for some paper titles.

Recommendation 1: Eliminate the need for some paper vehicle titles by offering electronic private party title transfers.

Vehicle Registration

Just as Senate Bill 2076 required a determination of the necessity of titling vehicles in Texas and any elements that could be eliminated, it similarly required an evaluation of vehicle registration.

The State of Texas and its 254 counties collect fees from users of Texas roads and bridges through vehicle registration to maintain the transportation network and help ensure roadways are safe. Vehicle registration generates more than $1.5 billion annually. These funds provide a critical supplement to waning Federal highway funds, making vehicle registration necessary.

In FY 2018 there were almost 24.9 million registered vehicles in Texas, including commercial and passenger motorized and non-motorized vehicles. There were 21,977,924 of these vehicles involved in the annual vehicle registration process. The largest volume of vehicle registrations occurs through annual vehicle registration renewals. Renewals are processed online, by mail, or in-person at county tax assessor-collector offices.

The issuance of a title and initial registration creates an ongoing operational expense to notify customers of registration expiration, process those renewals, and credential vehicles. Changes can be made at the time of title and initial registration to reduce or eliminate the need for ongoing operational expenses. The ongoing operational expenses related to the vehicle registration renewal process include:

1. *Notifying* the customer of their expiring vehicle registration.
2. *Processing* the customer's vehicle registration request either in-person, by mail, or online after vehicle inspection and insurance have been verified.
3. *Credentialing* the customer's vehicle by providing a registration sticker either in-person or through the mail (Figure 5).

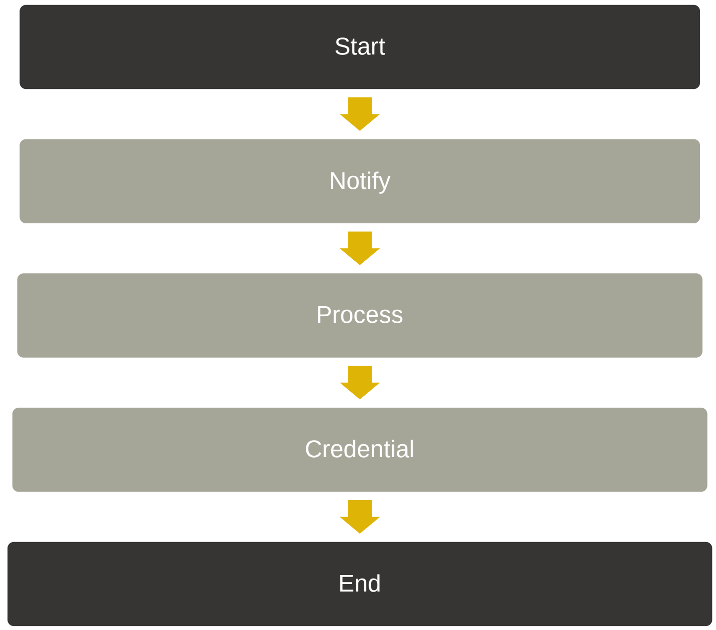

Figure 5. Typical vehicle registration renewal process flowchart

A variety of research methods were used to identify opportunities to eliminate or streamline key elements of the registration processes. Interviews, benchmarking, internet research, and process maps led to recommendations to improve the efficiency of current registration processes. Calculations confirmed the potential for cost savings.

In total, experts at six entities were interviewed as part of the effort to identify elements of the vehicle registration process which could be eliminated. These subject matter experts were from the TxDMV, the American Association of Motor Vehicle Administrators, the Pennsylvania Department of Transportation, the Nueces County Tax Assessor-Collector's Office, the Texas Department of Information Resources, and the Société de l'assurance automobile Québec. For the complete list of individuals interviewed, see Appendix 1: Interviews.

The remainder of this section of the study is broken out by the relevant registration process element of Registration Notification, Registration Processing, or Registration Sticker (credential). A recommendation for elimination or streamlining is included for each of these three major vehicle registration renewal steps.

Registration Notification

Registration notification is the first step in the vehicle registration renewal process (Figure 6). The customer will be notified of the need to renew their vehicle registration. Customers are notified via mail and may also choose to receive additional email reminders (eReminder).

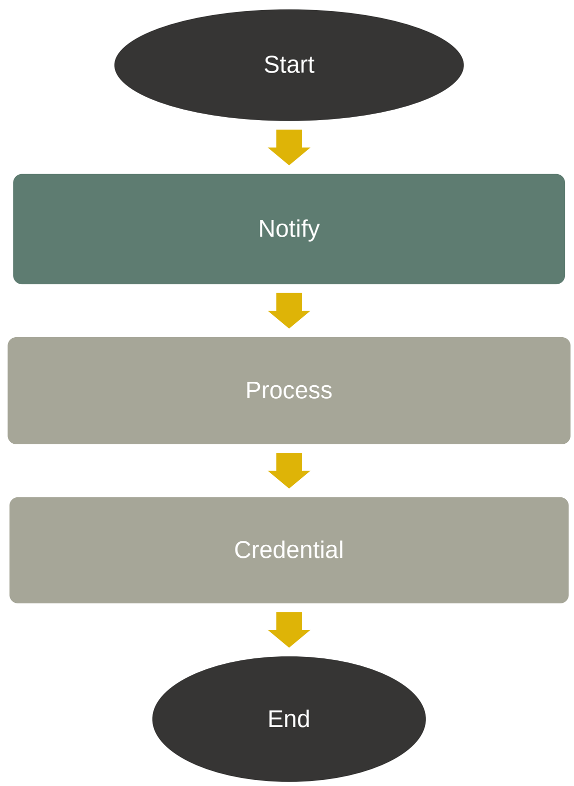

Figure 6. Typical vehicle registration renewal process flowchart with notification emphasis

A variety of research methods were used to identify opportunities to eliminate key elements of vehicle registration notifications. For the complete list of individuals interviewed, see Appendix 1: Interviews, and for benchmarking results, see Appendix 2: Benchmarking Results.

The research led to the recommendation to eliminate some mailed renewal notices by discontinuing mailed renewal notices for customers who sign up to be notified via email and text messages.

Vehicle Registration Notification in Texas

Currently, in Texas, customers are mailed a vehicle registration renewal notice approximately 60 days prior to their vehicle registration expiration date. The mail notification is sent to 100% of registrants whose vehicle registration will expire soon, and there is no ability to opt-out of these notifications. Interviews revealed that while all customers are mailed these notices, not all renewal notices reach their intended recipient, which can cause customer confusion and delays.

In addition to mailed renewal notices, Texas vehicle owners may choose to receive email reminders (eReminders). These eReminders are sent approximately three weeks before expiration and again approximately one week before expiration, if registration renewal has not been processed.

The current registration notification process timeline including mailed renewal notices and optional eReminders is summarized in Figure 7.

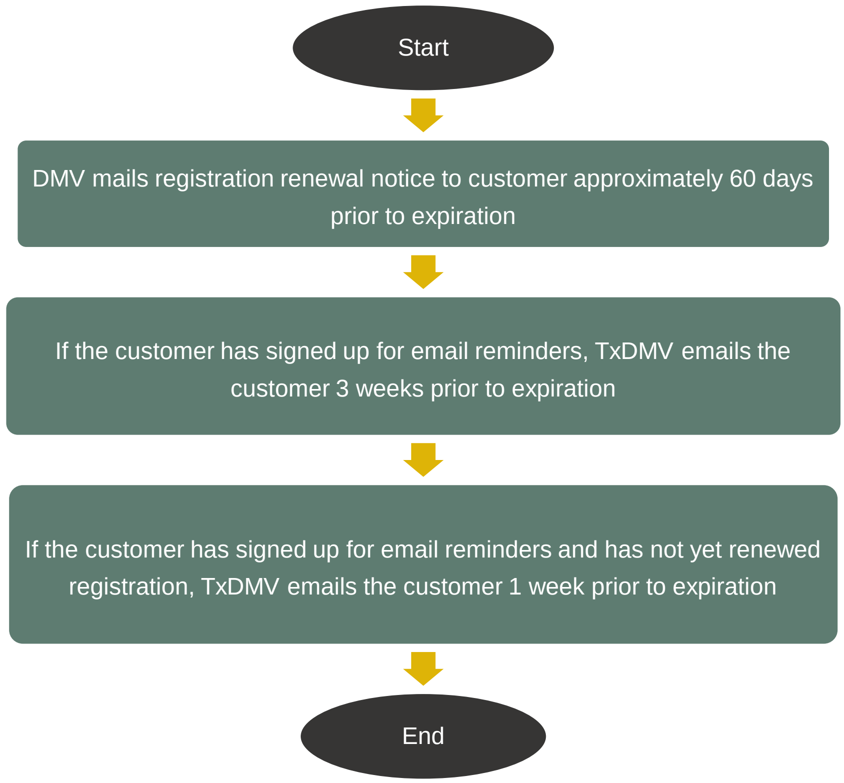

Figure 7. Current vehicle registration renewal notification flowchart

According to the TxDMV, the mandatory mailed renewal notice and the optional eReminder serve different purposes. The purpose of a mailed renewal notice is to prompt a customer to renew their vehicle registration online, by mail, or in-person, and to facilitate the renewal process. The purpose of the eReminder is to prompt a customer to renew their vehicle. The eReminder does not provide the customer an invoice that can be used to renew their registration. The eReminder, though, does contain the license plate number and last 4 digits of the VIN to expedite renewing online.

Customers signing up for the eReminder may not understand the different purposes and may have mistakenly thought they were signing up to receive their registration renewal notice by email instead of by mail. The TxDMV has plans to implement an email renewal notice (eRenewal) that would be similar to the mailed renewal notification and serve the same purposes as a mailed renewal notice. This email renewal notice would eliminate the ongoing operational expense associated with printing, inserting, and mailing a registration renewal notice.

Vehicle Registration Notification in Other Jurisdictions

The methods used to notify vehicle owners prior to registration expiration were collected for all 50 states and Washington, DC. Overall, benchmarking indicated that notification methods vary from state to state. Some states offer multiple notification methods. The most common method is via physical mail reminders, offered in 47 states and Washington, DC. The next most commonly used method, email, is used by 23 states and Washington, DC. Four states including Arkansas, Nebraska, New York, and Virginia use text message notifications. Two states allow customers to opt-in to registration renewal notification. Delaware utilizes automated phone calls as their notification.

Currently, 16 states and Washington, DC use some form of an opt-out option. In some cases, customers can choose to opt-out of the mail notifications. In others, the customer is automatically opted-out of mail notifications when they sign up for an electronic notification method via email or text message reminders.

Email and Text Message Registration Notification

After identifying the potential to eliminate some mailed renewal notices by opting electronic notification customers out of a duplicate mail notice, the procedural differences, potential cost savings, necessity of statute or rule changes, and general advantages and disadvantages were examined.

The primary goal of sending a registration renewal notification is prompting customers to renew their registration in a timely fashion. There are several things required to accomplish this goal, including customers receiving the notification, opening it, and acting. Not all customers receive their mailed notice and it is difficult to track if they do or do not.

Existing research was reviewed to understand if there is a difference in response rates between email and text messages. The research indicated text messages have a greater chance of prompting action. Researchers at the University of Notre Dame and Indiana University found when university students received a text message, voter registration increased over an email message (Bennion and Nickerson 2011). This corroborated findings by researchers at Ludwig-Maximillian University in Munich who found that response rates increased when text messages encouraging the use of coupons were sent (Reichhart, Pescher and Spann 2013). Notably, both studies targeted university students and may not apply generally. For a variety of reasons—including change of internet service provider, multiple email accounts, and spam filters—not all emails reach their intended audience. One study estimated 20% of emails are opened and 80% of text messages are opened (Aland 2017).

For the reasons evidenced by this research, relying on email alone may not be a sufficient notification method, but adding a text message option will ensure the TxDMV is doing as much as possible to minimize late registration renewal and reduce costs.

Procedural Differences

Currently, customers have two options regarding notifications:

1. Mail only notifications (renewal notices)
2. Mail notifications (renewal notices) and email reminders (eReminders)

After the TxDMV implements email notifications (eRenewal), it will be possible to offer a third option:

3. Email notifications with text message reminders

The current process for options one and two would not be changed. However, for those customers that choose option three, the process would change. Instead of a mailed renewal notice at approximately 60 days, they would receive an eRenewal followed by text message reminders at approximately three weeks and one week (Figure 8).

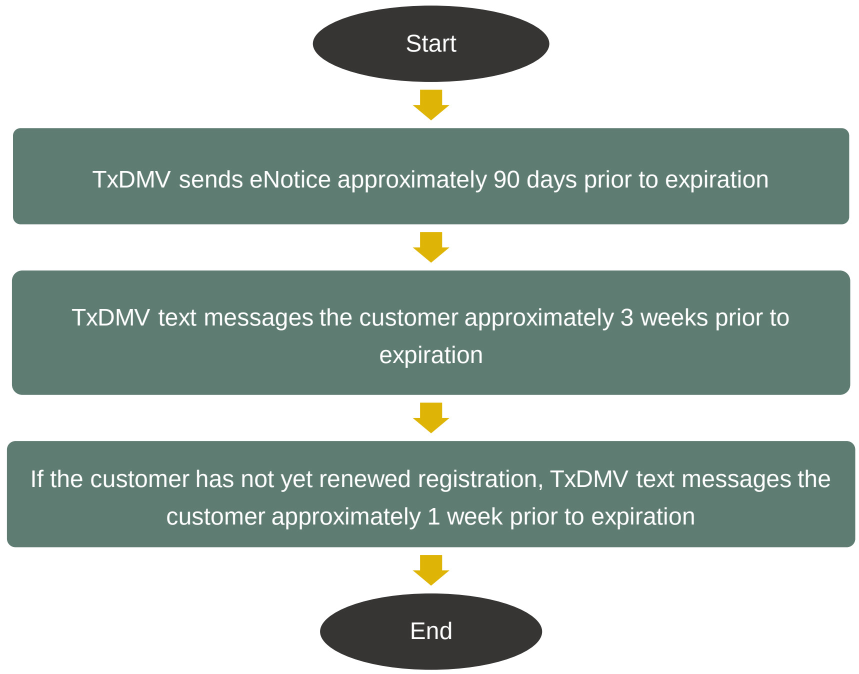

Figure 8. Future vehicle registration renewal notification flowchart for customers opting out of mailed renewal notifications for email and text renewal notifications

Strategic Business Partner Processes

Changes will be required for two of the TxDMV's strategic business partners' processes to implement the option for customers to be alerted of their upcoming registration renewal via email and text message notifications: Texas.gov and county tax assessor-collectors.

Texas.gov users renewing their vehicle registration will need to be presented with the new notification option to encourage enrollment, especially from customers who are already using digital services.

County tax assessor-collectors will similarly need to verbally inform walk-in customers who are renewing their vehicle registration of the new notification option and encourage their enrollment during their registration renewal transaction.

Both changes to partner processes will require changes to existing digital and physical forms to allow the capture of the necessary phone numbers to send text message reminders. Programming in the Registration and Title System (RTS) database will also be needed with an accompanying cost.

Operational Cost Savings

To explore the potential operational cost savings of changes to the vehicle registration renewal notifications, a cost estimate was developed. Estimates of the potential cost savings associated with this recommendation are based on base variables of the TxDMV's vehicle registration practices (Table 2).

The TxDMV incurs minimal expense to send eReminders and it is assumed the same in-house capability can also be used to send text message and email notifications.

Table 2. Base variables used to calculate registration notification cost savings estimates

Variable Name	Variable Value
Vehicles involved in the annual vehicle registration process (FY 2018)	21,977,924
Percent and number of customers notified by mail currently	100% 21,977,924
Percent and number of customers notified electronically	18.5% 4,065,916
Cost to mail renewal notifications	$0.4733
Cost to text/email auto-renewal notifications	$0

In FY 2018, the TxDMV spent approximately $10.4 million (Table 3) to mail renewal notices to customers.

Table 3. Fiscal Year (FY) 2018 registration renewal notification costs

Notification Type	Percent of Customers	Number of Customers	Cost per Notice	Estimated Cost
Physical mail	100%	21,977,924	$0.4733	$10,402,151
eReminder	18.5%	4,065,916	$0	-
Total			Total Cost	$10,402,151

Approximately 18.5%—or 4,065,916—of Texas vehicle owners were signed up to receive email reminder notifications. To estimate enrollment in the new notification option, it was assumed this same percentage of customers would enroll. If these 4 million customers enrolled in the new notification option, the TxDMV would no longer need to mail them a vehicle registration notification. The total customers receiving mailed notifications would be reduced from 21,977,924 to 17,912,008. At $0.4733 per mailed renewal notice, the annual notification costs would be reduced from $10,402,151 to $8,477,753. This change results in estimated operational cost savings of $1,924,398 annually.

Changes to Existing Statutes or Rules

No changes to existing statute are required to add text message or email registration renewal notifications. The current language in the Transportation Code is inclusive enough to incorporate various methods of vehicle registration renewal notifications. Modifications to 43 Texas Administrative Code Chapter 217, Subchapter B will be required to eliminate mailed renewal notices to all customers.

Advantages and Disadvantages

The advantages and disadvantages of adding an additional vehicle registration renewal notification to eliminate some mailed renewal notifications were considered before finalizing a recommendation.

ADVANTAGES

Adding a vehicle registration renewal notification option and eliminating some mailed renewal notices offers several benefits for different stakeholders in the vehicle registration renewal process.

In general, the change will reduce operational costs by an estimated $1,924,398.

- *Customers* would be able to customize the method of their renewal notifications which may increase the rate of timely compliance.
- The *TxDMV* would be able to encourage online registration renewal by providing a direct link to the registration renewal portal as part of the text message.
- Paper waste is reduced.

DISADVANTAGES

A text message notification option will require additional programming at an unknown cost and require the collection of both an email and phone number from participating customers.

Vehicle Registration Notification Recommendation

All vehicle registration renewal customers currently receive a mailed renewal notice and have the option to receive an email reminder. The TxDMV is currently investigating the ability to send an email notification with the same full functionality as the mailed renewal notice. As a result, the TxDMV has the potential to reduce operational costs by eliminating the mailed vehicle registration renewal notification for customers who choose email and text message notifications.

Arkansas, Nebraska, New York, and Virginia use text message notifications. Additionally, 16 states use some form of opt-out for mailed renewal notices. Research indicates using email as the only notification method risks many customers not receiving or opening the notification. Based on the research that shows text messages ability to prompt action over email and the concern of low open rates for email compared to text messages, including a text message as a requirement for electronic-only notifications is an important additional step to ensure notifications are serving their ultimate purpose of timely vehicle registration compliance.

Given the significant operational cost savings created by this recommendation and the supporting examples from other jurisdictions, it is recommended that the TxDMV eliminate some mailed renewal notices by offering email notifications with text message reminders as an alternative to mailed renewal notices.

Recommendation 2: Eliminate some mailed renewal notices by offering email notifications with text message reminders, in lieu of mailed renewal notices.

Registration Processing

Registration processing is the second step in the vehicle registration process (Figure 9). At this point, the customer has been notified of the need to renew their vehicle registration and should have had their vehicle inspected to ensure it meets safety standards and, in some counties, emissions standards. During processing, a customer's inspection and proof of insurance will be verified.

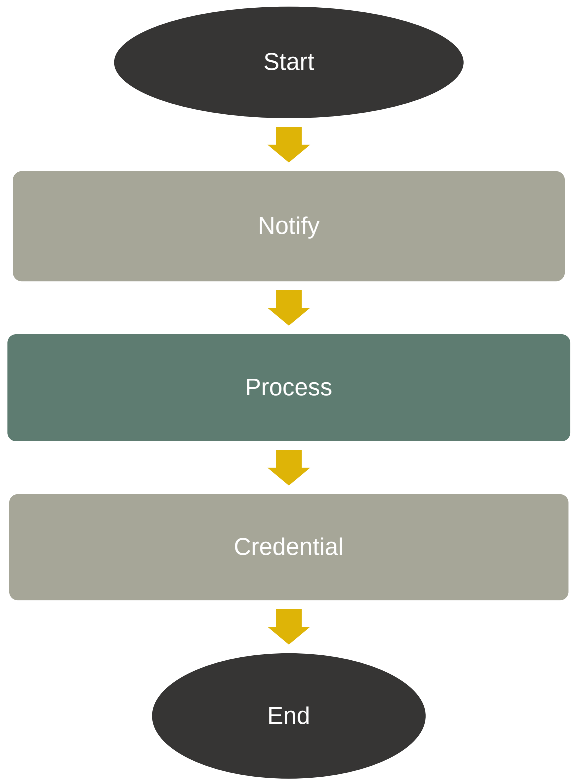

Figure 9. Typical vehicle registration renewal process flowchart with processing emphasis

Currently, passenger vehicle owners can choose from three methods to renew their vehicle registration: in-person, by mail, or online. Some county tax assessor-collectors also offer registration renewal by phone and in-person. The focus of this study was on those 76% of customers who choose to complete their vehicle registration renewal in-person (Figure 10).

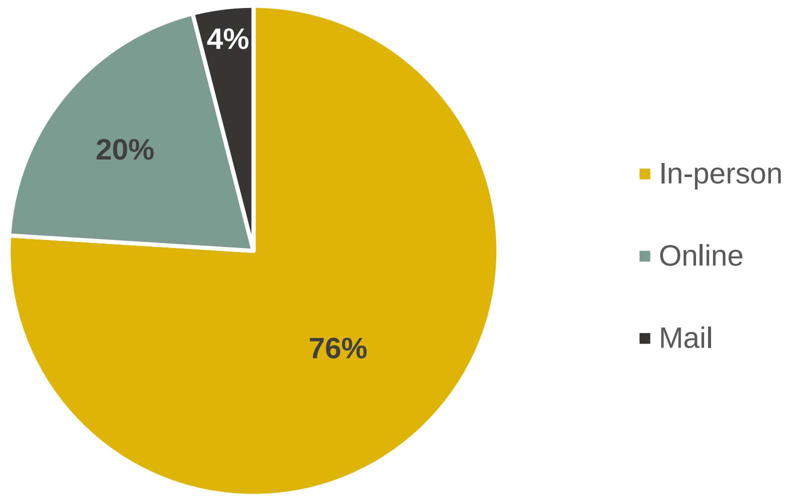

Figure 10. Percentage of customers served in-person, online, and by mail

A variety of research methods were used to identify opportunities to eliminate key elements of registration processing for annual passenger vehicle registration renewals. For the complete list of individuals interviewed, see Appendix 1: Interviews, and for benchmarking results, see Appendix 2: Benchmarking Results.

The research led to the recommendation of eliminating the need to serve some registration renewal customers in person by offering automatic registration renewal (auto-renewal) payments.

Vehicle Registration Processing in Texas

When executing the processing step of vehicle registration, a customer will typically go to a county tax assessor-collector's office. A renewal agent at the office will enter the customer's vehicle data and verify current inspection and insurance. Verification of inspection and insurance are generally automated electronic processes. Finally, the customer will pay the appropriate fees and the renewal agent will provide a receipt with the vehicle registration sticker (Figure 11). This process must currently be repeated annually by customers wanting to operate their vehicle on Texas roadways. Each year, a customer will have a 90-day renewal period in which they can complete their vehicle inspection and registration renewal.

Note: The registration sticker and receipt are issued as part of the processing step when renewing registration.

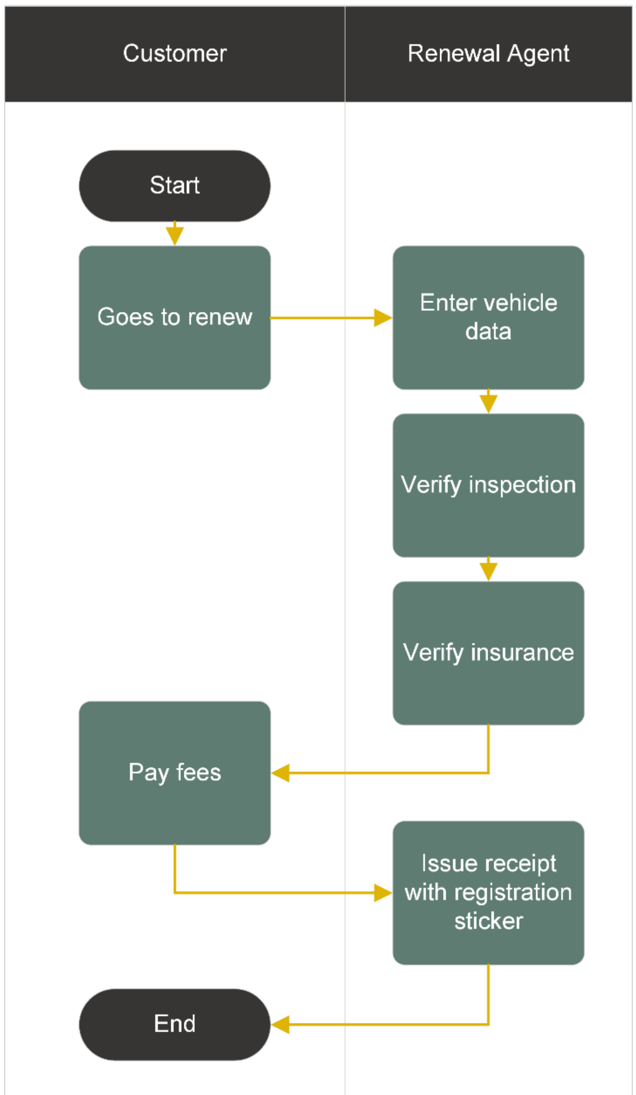

Figure 11. Current vehicle registration renewal flowchart (in-person)

Vehicle Registration Processing in Other Jurisdictions

Vehicle registration renewal can be accomplished through various methods, depending on the state, such as in-person, mail, and online. Almost all states allow a customer to renew their registration in person at the appropriate office. Rhode Island only allows registration renewal processing by mail or online. Verification of inspection depends on the state's individual inspection requirements. In general, the Texas vehicle registration methods and the in-person renewal process are like the methods and processes of other states.

As a result of these similarities, alternate methods for processing were researched in other countries. Australia and the UK are using auto-renewal to process registration renewals. Australia offers smaller payment increments including three- and six-month options in addition to the standard 12-month option, to provide more budget-friendly payments. The UK also allows customers to pay their registration fees in one, six-, and 12-month increments. The monthly installments proved to be very popular. Approximately 40% of UK residents signed up for monthly direct billing within the first 13 months of the option being available (Hull 2015).

Automatic Vehicle Registration Processing

After identifying the potential of an auto-renewal processing system, the procedural differences, potential cost savings, necessity of statute or rule changes, and general advantages and disadvantages were examined.

Procedural Differences

In-person registration customers—both at initial titling and registration, and during annual renewal—may wait in the office for assistance to process their transaction. Using this wait time to communicate the benefits of auto-renewal, while the experience is fresh on the customer's mind, could prompt customers to sign up for auto-renewal.

Customers already using online services could be prompted at the end of their transaction to decide whether to enroll in auto-renewal for the following year. These conversions, while they may be very successful, will not produce any immediate cost savings as the cost to renew online and automatically are the same. However, the conversions could improve on-time vehicle registration renewal.

By allowing auto-renewal, the annual process is simplified in such a way that it is difficult to depict. After enrolling in the system, a customer's annual renewal will be processed using an automated batch process. The process will identify all enrolled customers whose renewal period is open, verify inspection, verify insurance, and debit the stored payment method (Figure 12).

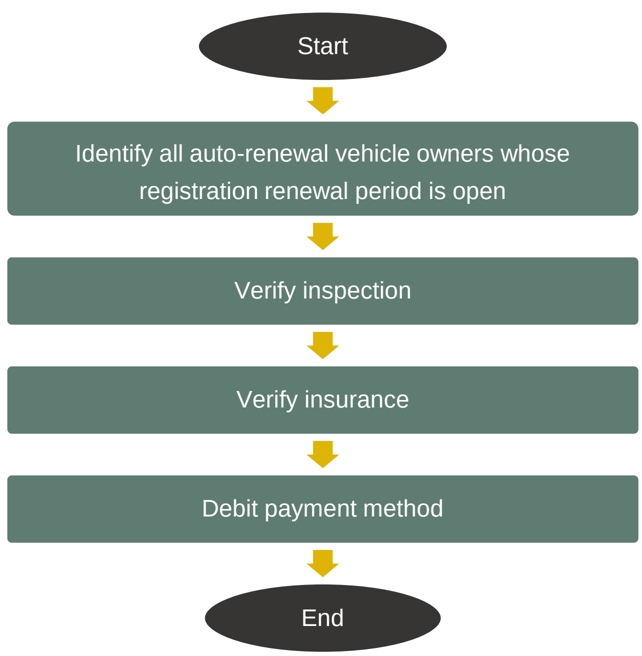

Figure 12. Future vehicle registration renewal flowchart (Auto-renewal)

The entity processing these transactions (Texas.gov) would retain a user's financial and vehicle information and then perform periodic registration renewal transactions without the need of user interaction. Customers would be notified of the pending charge with the option to cancel if the vehicle had been sold, was inoperable, etc.

Strategic Business Partner Processes

Changes will be required for two of the TxDMV's strategic business partners' processes to implement auto-renewal: Texas.gov and county tax assessor-collectors.

Texas.gov will need to develop the capability to offer auto-renewal capabilities. The system will require the storage of customers payment information and added security measures. This change could result in a higher transaction fee for TxDMV.

The in-person process would not change for county tax assessor-collectors. In order to reach significant enrollment, however, county tax assessor-collectors would need to encourage customers to sign up for auto-renewals when completing in-person renewals, both at initial titling and registration and during annual renewal. In the future, customer traffic volumes at county tax assessor-collectors offices should be reduced as customers opt-in to auto-renewal.

Dealers would also need to encourage customers to sign up for auto-renewals when completing the initial titling and registration process.

Operational Cost Savings

To explore the potential operational cost savings of changes to the title process, a cost estimate was developed. Estimates of the potential cost savings associated with this recommendation are based on base variables of the TxDMV's vehicle registration practices (Table 4).

Table 4. Base variables used to calculate registration renewal processing cost savings estimates

Variable Name	Variable Value
Vehicles involved in the annual vehicle registration process (FY 2018)	21,977,924
Percent and number of customers renewing vehicle registration in person and by mail	80% 17,582,339
Percent and number of customers renewing vehicle registration online	20% 4,395,584
Cost to process in-person/mail vehicle registration renewal	$2.4695
Cost to process online vehicle registration renewal	$0.8497

In FY 2018, 80% of the annual registration renewal customers processed their renewal payment in person or by mail, at a cost to the TxDMV of $2.4695. The TxDMV spent approximately $47.2 million processing registration requests in FY 2018 through either a county tax assessor-collector's office, by mail, and online (Table 5). More than 90% of this total cost can be attributed to in-person and mail renewals. Several factors contribute to the cost: 1) the largest percentage of customers use these renewal options, and 2) serving customers in-person or by mail costs approximately three times as much as it does to process online renewals.

Table 5. Fiscal Year (FY) 2018 registration renewal processing costs

Transaction Method	Number of Customers Using Method	Cost to Process Each Renewal	Total Processing Cost
In-person/mail in	17,582,339	$2.4695	$43,419,587
Online	4,395,585	$0.8497	$3,734,928
		Total Cost	$47,154,515

The adoption rate of customers converting from an in-person or mail in renewal to an online renewal could be a predictor of the adoption rate for auto-renewal. Historically, the adoption rate of customers choosing online registration renewal over in-person or mail renewal has been slowly growing. However, the rate of customers renewing online has plateaued at around 20%. Customers incorrectly assume online registration renewal is costly. Customers with registration about to expire or already expired are not aware their online registration receipt is proof of registration for 30 days. Customers requesting auto-renewal could enroll at any point in the registration year either online or in-person at the county tax assessor-collector office.

There would be an expense to develop and implement auto-renewal capability and an ongoing operating expense to operate and maintain this option. However, every in-person renewal customer who converts to an auto-renewal customer would save TxDMV $2.4695 annually in ongoing operating expense. If 5% of in-person customers converted, it is estimated TxDMV could save $1.8 million annually (Table 6). These savings would decrease if the transaction fee charged by Texas.gov increased.

Table 6. Estimated future registration renewal costs

Transaction Method	Percent of Customers Using Method	Number of Customers Using Method	Cost to Process Each Renewal	Total Processing Cost
In-person/mail in	75	16,483,443	$2.4695	$40,705,862
Online	20	4,395,585	$0.8497	$3,734,928
Auto-renewal	5	1,098,896	$0.8497	$933,732
			Total Cost	$45,374,523

This study assumes the cost of processing an auto-renewal is the same as the cost for processing an online vehicle registration renewal. This assumption is due in large part to the UK experience where there is a 5% surcharge for paying monthly, but the customer bears this cost.

Typically, entities using auto-renewal alert customers of the upcoming payment processing date via text message or email. If the TxDMV adopted this policy, the cost of mailing registration notices to auto-renewal customers would decrease based on the assumption that the TxDMV can send emails and text messages at minimal cost.

Changes to Existing Statutes or Rules

Government Code, Chapter 2054, provides broad authority for the Texas Department of Information Resources to provide internet and payment processing services to government agencies in Texas. While it does not specifically allow for development of a system capable of processing auto-renewal payments, this chapter does not appear to require modifications to allow this capability.

No change to the Transportation Code would be required to allow the option for auto-renewal. Modifications to 43 Texas Administrative Code Chapter 217 would be required to allow auto-renewal, and changes to both Transportation Code and Texas Administrative Code would be required if payment options other than for an annual period were offered.

Advantages and Disadvantages

The advantages and disadvantages of implementing an auto-renewal process to eliminate the need to serve some in-person vehicle registration renewal customers were considered before finalizing a recommendation.

ADVANTAGES

Auto-renewal offers several benefits for different stakeholders in the vehicle registration renewal process.

In general, the system will reduce operational costs by approximately $1.8 million annually. The system would also be extendible to create new efficiencies. For example, the system could be setup to allow customers to automatically prepay their annual registration in installments to reduce the financial strain caused by one lump-sum payment.

- The *TxDMV* would benefit in many ways. Currently, the TxDMV has a significant challenge converting in-person users to online users. This is due in part to customers' habits and the difficulty of educating them at the right time for successful conversion. The benefit of an auto-renewal capability is that customers could be signed up *during* an in-person transaction. This timely conversion would break the current cycle. This unique opportunity to educate and enroll customers could have a positive effect on success that is not currently available when educating by the current methods employed. At the same time these customers are converted to auto-renewal, they could also be converted to text message and email notifications.

- *Customers* would benefit from a new option to simplify their vehicle registration renewal payment process. This option will reduce the number of locations they typically visit to complete the registration.
- *The State of Texas* would benefit from any increase in on-time renewal rates as delayed registration impacts revenue and planning.
- *Texas.gov,* as the host of the system, would benefit from a larger volume of customers who are familiar with their platform. These customers would be more likely to use other online services offered by Texas.gov, such as driver license renewal.
- *County tax assessor-collectors* will benefit from reduced in-office customer volumes that often lead to long in-office wait times.

DISADVANTAGES

The requirements to have vehicle inspections and current insurance prior to issuance of registration has the potential to cause customers enrolled in auto-renewal to still fail to be renewed. This would be no different than the current situation when customers fail to receive a timely inspection but is nonetheless an issue for auto-renewal.

New issues, though, would arise from this system that involve expired payment information and educating customers on how to renew their vehicle registration if they fail to receive or pass an inspection before the auto-renewal processes. Additionally, customers would need to be sure to cancel their auto-renewal when a vehicle is sold or no longer operable, or the customer moves out of state. TxDMV could develop a programmatic solution, at an unknown cost, that canceled auto-renewal for a vehicle when the title is transferred or reported as surrendered out-of-state. Customers would also need to update their payment information when payment information becomes invalid. Furthermore, a process would need to be developed to address payment information that has not been appropriately updated by a customer.

In the short-term, processing times at tax assessor-collectors' offices could increase as renewal agents discuss the details of the auto-renewal option prior to signing up customers.

Vehicle Registration Processing Recommendation

Most vehicle registration renewal customers complete their transaction in person. In-person and by mail are the most expensive methods the TxDMV offers for processing these transactions as compared to online renewal. As a result, the TxDMV has the potential to reduce operational costs by introducing an auto-renewal option.

The UK and Australia both employ automatic payment for similar vehicle registration purposes. The UK has published results that indicate great popularity.

Although these examples come from outside the US, millions of Americans are familiar with the concept of auto-renewal for things like gym memberships and magazine subscriptions. Companies use auto-renewal to increase customer convenience and to insure payments are made on-time.

Given the many advantages to a variety of stakeholders in the vehicle registration renewal process and the few disadvantages that could generally be mitigated by returning to the existing process, it is recommended that the TxDMV eliminate the need to serve some registration renewal customers in person by offering auto-renewal payments.

Recommendation 3: Eliminate the need to serve some customers in person by offering automatic registration renewal (auto-renewal) payments.

Registration Sticker

Credential is the third and final step in the vehicle registration renewal process in Texas (Figure 13). The registration sticker—which serves as an external indicator of the completion of the vehicle registration credentialing process—includes an expiration month and year. Vehicles without a windshield receive a license plate sticker.

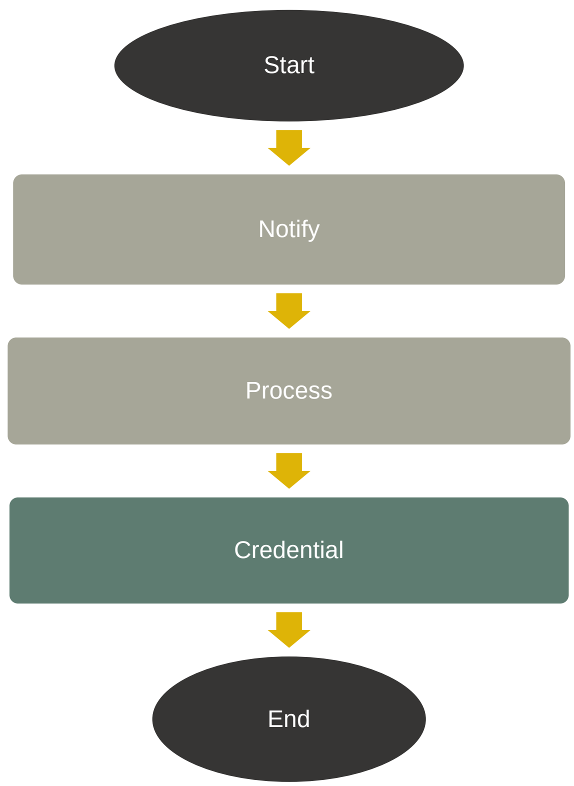

Figure 13. Typical vehicle registration renewal process flowchart with credential emphasis

Registration stickers are used by law enforcement officers to enforce registration laws and for probable cause traffic stops, though they ultimately rely on the state's motor vehicle database for registration information. Military bases, some municipalities, home owner's associations (HOAs), and other organizations sometimes use registration stickers to determine a vehicle's registration expiration date.

A variety of research methods were used to identify opportunities to eliminate key elements of vehicle registration sticker issuance for passenger vehicles. For the complete list of individuals interviewed, see Appendix 1: Interviews and for benchmarking results, see Appendix 2: Benchmarking Results.

The research undertaken for this study led to the recommendation of eliminating the registration sticker.

Vehicle Registration Stickers in Texas

Passenger vehicles and light trucks currently utilize a sticker placed in the lower corner of their windshield on the driver's side to demonstrate compliance with registration and inspection requirements. The registration sticker is specific to each vehicle and includes the county the vehicle is registered in, the vehicle's license plate number, and a portion of the VIN. Motorcycles and trailers display a smaller sticker on the license plate. The stickers are required to be replaced annually to indicate a valid vehicle registration and inspection.

Depending on how a customer chooses to renew their vehicle registration, the method for receiving their registration sticker will vary. If a customer renews their vehicle registration in person, they will receive their receipt and registration sticker at the conclusion of their transaction. If a customer renews online, their receipt serves as temporary proof of registration until receiving the registration sticker in the mail (Figure 14).

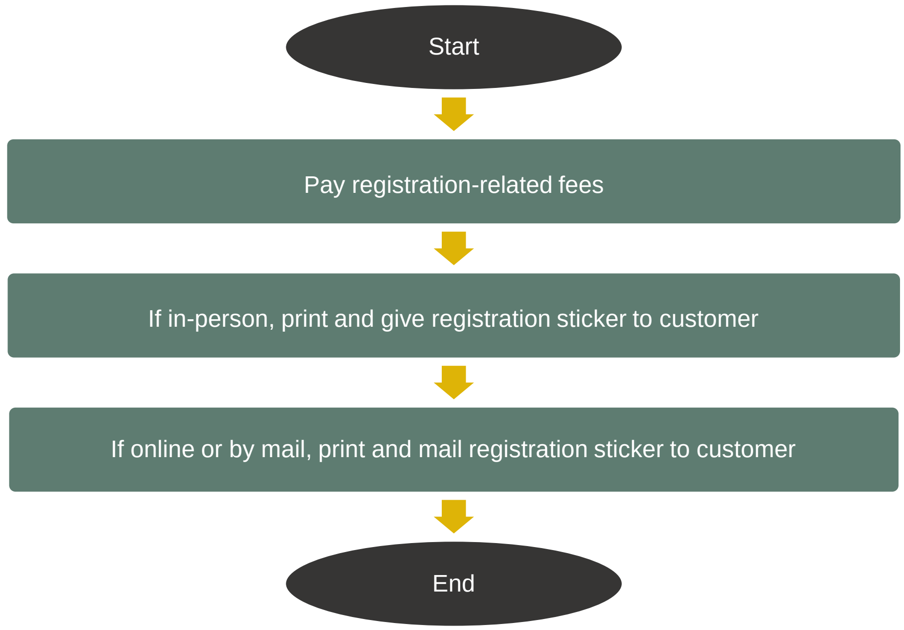

Figure 14. Current vehicle registration sticker issuance flowchart

Customers who renew their vehicle registration online or by mail must wait for their registration sticker to be mailed to them. Customers renewing at the end of the month might not receive their sticker until the following month, even though they had renewed on time. To mitigate this issue, the law was changed so that online registration renewal receipts can be used temporarily as registration verification until the sticker is processed and mailed.

Vehicle Registration Stickers in Other Jurisdictions

Currently, there are three ways states provide verification of vehicle registration payment. Most states provide an externally visible sign indicating current registration. The most common method is license plate stickers. A license plate credential is a sticker usually placed in the upper right-hand corner of the license plate. In total, 45 out of 50 states use license plate stickers. Another credentialing method is windshield stickers where drivers place a registration sticker on the inside of their windshield. Only Texas, New York, and Washington, DC use this method.

While Pennsylvania no longer requires a vehicle registration sticker, they do require an inspection sticker. The Pennsylvania inspection sticker serves a dual role in that it also signifies current registration. New Jersey similarly has no registration sticker but does use inspection stickers. Connecticut does not use inspection stickers, and as of 2010, does not use external registration stickers. Instead, Connecticut requires vehicle owners to carry documented proof of registration in their vehicles.

In general, the fact that Texas uses a sticker is consistent with most states, however its use of a registration sticker placed on the windshield makes it somewhat unique. As a result of these similarities, alternate methods for processing were researched in other countries.

Three provinces in Canada do not require vehicle registration or inspection stickers. In Quebec, periodic safety inspections and emissions testing are not required for many vehicle classes. Therefore, without a vehicle registration sticker, emissions sticker, or safety inspection sticker, no stickers are required to be placed on the vehicle. Automated License Plate Readers (ALPRs) are used to enforce registration requirements. Montreal Police have been using ALPRs since February 2011 and the Quebec Provincial Police have been using ALPRs since 2012. Manitoba similarly does not require annual inspections. Saskatchewan does require vehicle inspections, but only issues a certificate that must be presented to register the vehicle.

In 2013, Australia eliminated the need for light vehicles, including motorcycles and trailers up to approximately 10,000 pounds, to display a registration sticker. Vehicles are required to pass a pre-registration inspection. Australian police use ALPRs to automatically detect if a vehicle is registered and can impose a fine of approximately $400 USD each for being unregistered or uninsured. Unregistered vehicles can be seized, and the compulsory liability insurance is invalid if the vehicle is unregistered at the time of an accident (Services 2018).

In 2014, the UK eliminated their registration sticker, or tax disc, as they call it, relying instead on an electronic system to verify up-to-date payments (Cristie 2014). A study conducted approximately three years after the registration sticker was eliminated indicated the UK had experienced an increase in unpaid registration fees. In the three-year period, the number of vehicles with unpaid fees increased threefold to 1.8%. Confusion over a new law, implemented at the same time as the law eliminating registration stickers, appeared to be partially responsible for some of the increase. Used cars--for which registration stopped transferring to the new owner—accounted for approximately one-third of the non-complying vehicles (Topham 2017).

Vehicle Registration Sticker Elimination

One reason cited to keep a visible registration sticker was because of concerns expressed by law enforcement. A 2011 study, *Evaluation of the Use of Registration Stickers,* conducted by Pennsylvania State University for the Pennsylvania Department of Transportation had several key findings related to the elimination of registration stickers. This study evaluated the costs and benefits of eliminating registration stickers and recommended eliminating the sticker for simplicity, cost savings, elimination of potential sticker theft, and positive reports from other programs. The study was based on Connecticut's discontinuation of vehicle registration stickers.

Specifically, the report states "there is no statistical evidence that the elimination of stickers has any statistically significant impact on the number of vehicle registrations, the ability of police to make drug arrests…" (Garvey, et al. 2011).

Other conclusions reported that:

- Eliminating the registration sticker did not reduce payment of registration fees.
- Eliminating the registration sticker did not reduce the ability of law enforcement to perform their duties.

Additionally, as an enforcement device, registration stickers lack visibility. The registration sticker can be difficult to view when travelling in the same direction or opposite direction. The placement or size of the registration stickers; the distance between two vehicles; and the speed of the two vehicles can make it difficult to read the stickers. Furthermore, during low light conditions, the stickers can be difficult to read.

Access to vehicle registration data to law enforcement via the Texas Law Enforcement Telecommunications System (TLETS) and emerging technologies such as automatic license plate readers render the registration sticker less necessary to validate current registration. In the event of a traffic stop where law enforcement is unable to verify current registration via TLETS, the registration receipt could act as the driver’s proof of valid registration.

Procedural Differences

If the registration sticker is eliminated, the typical process for issuing a credential would not change dramatically from the current process, except there is no sticker. Instead of printing a receipt on special paper for in-person customers, the receipt would be printed on standard paper stock. Customers renewing by mail will be mailed a receipt. Customers completing an online renewal would print a receipt for themselves. This change would allow the TxDMV to eliminate the mailing process for distributing registration stickers for vehicle registration renewals which occur online (Figure 15).

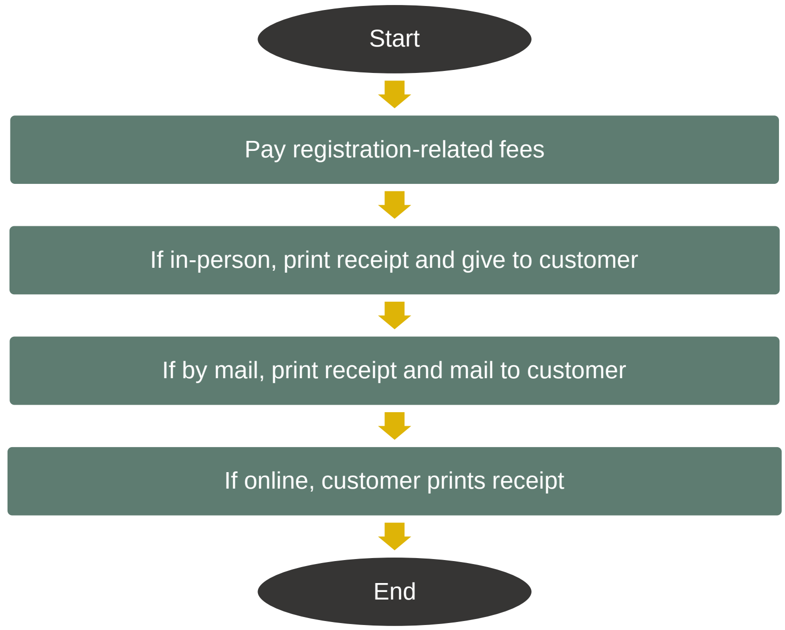

Figure 15. Future vehicle registration sticker issuance flowchart

Strategic Business Partner Processes

County tax assessor-collectors will no longer need to print registration stickers but will need to continue to print a receipt.

The department's vendor would no longer need to supply the current registration sticker paper.

Operational Cost Savings

Cost estimates were completed to calculate the savings if registration stickers were discontinued.

To explore the potential operational cost savings of eliminating the registration sticker, a cost estimate was developed. Estimates of the potential cost savings associated with this recommendation are based on base variables of the TxDMV's vehicle registration practices (Table 7).

Table 7. Base variables used to calculate auto-renewal cost savings estimates

Variable Name	Variable Value
Vehicles involved in the annual vehicle registration process (FY 2018)	21,977,924
Percent and number of customers renewing vehicle registration in person	76% 16,703,222
Percent and number of customers renewing vehicle registration by mail	4% 879,117
Percent and number of customers renewing vehicle registration online	20% 4,395,584
Cost to create and distribute sticker for in-person and by mail customers	$0.17
Cost to create and distribute sticker for online customers	$0.60
Cost to print receipt for in-person and by mail customers (cost of standard paper and toner)	$0.0167
Cost to print receipt for online customers	$0

The method for receiving a vehicle registration sticker depends on the method the customer used to renew their registration. In total, the TxDMV spends approximately $5.6 million on registration sticker distribution (Table 8).

Table 8. Estimated current registration sticker costs

Registration Method	Percent of Customers	Number of Customers	Cost to Create and Distribute Sticker	Total Cost
In-person	76%	16,703,222	$0.17	$2,839,548
By mail	4%	879,117	$0.17	$149,450
Online	20%	4,395,585	$0.60	$2,637,351
			Total Cost	$5,626,349

To replace the registration sticker with a printed registration renewal receipt, the TxDMV would need to purchase standard paper and toner to print receipts for customers who renew in-person and by mail, at an estimated cost of approximately $275,000 (Table 9).

Table 9. Estimated future registration sticker costs

Registration Method	Percent of Customers	Number of Customers	Cost to print Receipt	Total Cost
In-person	71%	15,604,326	$0.0167	$260,592
Mail-in	4%	879,117	$0.0167	$14,681
Online	25%	5,494,481	$0	$0
			Total Cost	$275,273

By eliminating the registration sticker and substituting a receipt printed on standard paper, the TxDMV could reduce their annual costs associated with printing and distributing registration stickers by $5,351,076.

Changes to Existing Statutes or Rules

Changes would be required to the Transportation Code to eliminate the display of a current registration sticker when operating a vehicle on public roads. Changes would also need to be made to 43 Texas Administrative Code, Chapter 217, Subchapter B.

Advantages and Disadvantages

The advantages and disadvantages of eliminating the vehicle registration sticker were considered before finalizing a recommendation.

ADVANTAGES

Elimination of the registration sticker offers several benefits for different stakeholders in the vehicle registration renewal process.

In general, the change will reduce operational costs, saving almost $5.4 million per year. The change will also enable other potential efficiencies. For example, additional registration periods could be offered without the need to print new stickers upon each expiration and renewal. This example would need to be studied before implementation because of the potential effect on revenue offering extended or shortened registration periods may have.

- *Customers* would not be required to obtain or affix a registration sticker. Anecdotally, feedback from some customers renewing in-person at the end of the month indicated they had chosen to renew in-person—instead of online—to make sure they had their registration sticker in time. Eliminating the sticker would allow customers with similar concerns to renew online and print their receipt immediately, thereby potentially increasing online and auto-renewals.

DISADVANTAGES

The discontinuation of registration stickers may cause law enforcement officers concern that their ability to enforce registration requirements would be negatively affected or that the probable cause created by expired registration stickers would similarly affect their ability to enforce the law.

Military bases, and some schools, churches, municipalities, and HOAs may need to find alternate methods to monitor vehicle registration.

Because most states have registration credentials, law enforcement officers in other jurisdictions would have to be made aware of the significant change to Texas' practices to ensure Texas drivers in other states are not subjected to undue hardship for not having a registration sticker.

Vehicle Registration Credential Recommendation

All registered vehicles in Texas must currently display valid registration with a registration sticker. As a result, the TxDMV has the potential to reduce operational costs by eliminating the registration sticker requirement.

Connecticut, the UK, Australia, and provinces in Canada all serve as examples of jurisdictions with no vehicle stickers. ALPRs and access to databases serve as the methods of enforcement in these jurisdictions.

As an enforcement device, the registration sticker affixed to the front of the vehicle in an unilluminated location is not effective in all conditions. Pennsylvania's research of Connecticut's implementation showed no statistically significant impact of no sticker on either registration payments or law enforcement's ability to perform their duties.

Given the significant operational cost savings created by this recommendation and the supporting examples from other jurisdictions, it is recommended that the TxDMV eliminate the registration sticker. This change would require significant communication and outreach with other jurisdictions to ensure a smooth transition.

Recommendation 4: Eliminate the registration sticker.

Conclusions

The Texas State University research study was required by SB 2076 to determine the necessity and efficiency of the titling and registration of vehicles in Texas to identify any elements of vehicle titling and registration programs that could be eliminated. The research used mixed methods including interviews, benchmarking, internet research, process mapping, literature review, and cost estimates.

The necessity of vehicle titling and registration was determined first. For the prevention of vehicle theft, improper transfer of vehicles, and fraud, vehicles titles are necessary. For the collection of fees from users of Texas roads and bridges to maintain the transportation network and help ensure the safety of the travelling public, vehicle registration is necessary.

After the necessity of titling and registration were determined, the efficiency of these processes was evaluated. The research led to four recommendations eliminating some unnecessary elements of the vehicle titling and registration processes. The recommendations from this study address the title process, and the three facets of registration: notification, processing, and credentialing stickers.

The four recommendations detailed in this report include:

1. Eliminate the need for some paper vehicle titles by offering electronic private party title transfers.
2. Eliminate some mailed renewal notices by offering email notifications with text message reminders, in lieu of mailed renewal notices.
3. Eliminate the need to serve some customers in person by offering automatic vehicle registration renewal (auto-renewal) payments.
4. Eliminate the registration sticker.

Adopting all four of the recommendations would save approximately $9.1 million in operational costs annually. Implementing the registration sticker recommendation requires a change to Chapter 502 of the Transportation Code to eliminate the registration sticker. Each of the recommendations will require changes to the TxDMV's rules in the Texas Administrative Code as outlined in the previous sections of this study.

Looking ahead, conducting this research has made it clear that the future of vehicle titling and registration will continue becoming more electronic and automated. It is easy to imagine a future with a web portal and phone application in which citizens have access to a private account. This private account could provide access to up-to-date credential documentation, titles for vehicles owned, but also other government agency documents, such as driver licenses, fishing licenses, and countless other credentials. The phone application could be used to send 'push' notifications to users, further bypassing mail as a correspondence method. This same application could be used to renew expiring vehicle registration, transfer titles, and other actions. At that point, the phone application could perform the majority of the steps of vehicle registration that are the TxDMV's responsibility.

The recommendations from this study do not go as far as recommending this web portal and phone application, but instead, provide concrete steps the TxDMV can take on the path to such a future. The development of a digital system to privately transfer vehicle titles will require user accounts and the ability to securely view personal records, currently out of view. The collection of phone numbers for use as a communication medium will be a clear step towards increased usage of current phone technology. The automatic renewal of expiring vehicle registration will promote a more efficient automated process for routine processes. Finally, the elimination of the vehicle registration sticker will make it possible to use electronic technologies to credential and enforce vehicle registration requirements.

Appendices

Appendix 1: Interviews

Throughout the research process, multiple subject matter experts in the titling process were interviewed. Table 10 below indicates the individuals interviewed, their title, their organization, and whether they were interviewed on titling, registration, or both.

Table 10. Interviewed experts with entity, name, title, and area of expertise

Entity	Interviewee	Title	Area of Expertise
Nueces County	Kevin Kieschnick	Tax Assessor-Collector	Titling/Registration
Texas Department of Information Resources	Todd Kimbriel	Deputy Executive Director, State Chief Information Officer	Titling/Registration

Entity	Interviewee	Title	Area of Expertise
Texas Department of Information Resources	Jennifer Buaas	Director of Engineering	Titling/Registration
American Association of Motor Vehicle Administrators	Catherine Curtis	Director, Vehicle Programs	Titling/Registration
American Association of Motor Vehicle Administrators	Casey Garber	Manager, Vehicle Programs	Titling/Registration
Texas Department of Motor Vehicles	Clint Thompson	Chief of Titles, Vehicle Titles and Registration Division	Titling
Texas Department of Motor Vehicles	Jeremiah Kuntz	Director, Vehicle Titles and Registration Division	Titling

Entity	Interviewee	Title	Area of Expertise
Arizona Department of Transportation	Eric Jorgensen	Motor Vehicle Division, Director	Titling
Texas Department of Motor Vehicles	Candy Southerland	Chief of Registration, Vehicle Titles and Registration Division	Registration
Société de l’assurance automobile Québec	Lisa L.	Customer Service Agent	Registration

Appendix 2: Benchmarking Results

Benchmarking information was collected on select vehicle title and registration practices in all 50 states and the District of Columbia. The information was gathered through online research from state websites and public data. In limited instances, phone contact was made to attempt to accurately represent the jurisdiction's practices.

Titles

Information was collected regarding whether jurisdictions processed titles in-person, by mail, or using electronic methods (Table 11).

Table 11. Other jurisdictions private party transfer title methods

State	In-Person	Mail-In	Electronic
Alabama	Y		
Alaska	Y	Y	
Arizona	Y		Y
Arkansas	Y		
California	Y	Y	
Colorado	Y		
Connecticut	Y		

State	In-Person	Mail-In	Electronic
Delaware	Y		
Florida	Y		
Georgia	Y		
Hawaii	Y	Y	
Idaho	Y		
Illinois	Y		
Indiana	Y		
Iowa	Y		
Kansas	Y		
Kentucky	Y		
Louisiana	Y		
Maine	Y		
Maryland	Y		
Massachusetts	Y		
Michigan	Y		
Minnesota	Y		
Mississippi	Y		

State	In-Person	Mail-In	Electronic
Missouri	Y	Y	
Montana	Y		
Nebraska	Y		
Nevada	Y		
New Hampshire	Y		
New Jersey	Y		
New Mexico	Y		
New York	Y	Y	
North Carolina	Y		
North Dakota	Y		
Ohio	Y		
Oklahoma	Y		
Oregon	Y	Y	
Pennsylvania	Y		
Rhode Island		Y	
South Carolina	Y	Y	
South Dakota	Y		

State	In-Person	Mail-In	Electronic
Tennessee	Y		
Texas	Y	Y	
Utah	Y		
Vermont	Y		
Virginia	Y		
Washington	Y	Y	
West Virginia	Y	Y	
Wisconsin	Y	Y	Hybrid
Wyoming	Y		
State Total	49	12	2
District of Columbia	Y		

Registration

Information was collected on registration notifications, processing, and stickers. Specifically, regarding notifications, information was collected on whether state's use mail, email, or texts, and whether there was a mail opt-out if texts or emails were offered (Table 12). Regarding processing, information was collected whether state's processed registration renewals by mail or online; and regarding stickers, information was collected on whether state's used license plate or registration stickers, or no sticker to indicate proof of current registration (Table 13).

Table 12. Other jurisdictions vehicle registration notification practices

State	Mail	Email	Text	Mail Opt-Out
Alabama	Y			
Alaska	Y			
Arizona	Y	Y		
Arkansas	Y	Y	Y	Y
California	Y	Y		
Colorado	Y			
Connecticut	Y	Y		
Delaware		Y	automated phone calls	Y
Florida	optional			

State	Mail	Email	Text	Mail Opt-Out
Georgia	Y			Y
Hawaii	Y			
Idaho	Y			
Illinois	Y	Y		Y
Indiana	Y			
Iowa	Y			
Kansas	Y			
Kentucky	Y			
Louisiana	Y			
Maine	optional			
Maryland	Y	Y		Y
Massachusetts	Y	Y		Y
Michigan	Y			
Minnesota	Y	Y		
Mississippi	Y	Y		Y
Missouri	Y			

State	Mail	Email	Text	Mail Opt-Out
Montana	Y			
Nebraska	Y	Y	Y	Y
Nevada	Y			
New Hampshire	Y			
New Jersey	Y			
New Mexico	Y			
New York	Y	Y	Y	Y
North Carolina	Y	Y		Y
North Dakota	Y	Y		Y
Ohio	Y	Y		Y
Oklahoma	Y	Y		Y
Oregon	Y			
Pennsylvania	Y			
Rhode Island	Y			
South Carolina	Y			
South Dakota	Y	Y		Y

State	Mail	Email	Text	Mail Opt-Out
Tennessee	Y	Y		
Texas	Y	Y		
Utah	Y	Y		
Vermont	Y			
Virginia	Y	Y	Y	Y
Washington	Y	Y		Y
West Virginia	Y			
Wisconsin	Y	Y		
Wyoming	Y			
State Total	47	24	4	16
District of Columbia	Y	Y		Y

Table 13. Other jurisdictions vehicle registration processing and sticker methods

States	Processing			Stickers		
	In-Person	By Mail	Online	License Plate	Windshield	None
Alabama	Y	Y	Y	Y		
Alaska	Y	Y	Y	Y		
Arizona	Y	Y	Y	Y		
Arkansas	Y	Y	Y	Y		
California	Y	Y	Y	Y		
Colorado	Y	Y	Y	Y		
Connecticut	Y	Y	Y			Y
Delaware	Y	Y	Y	Y		
Florida	Y	Y	Y	Y		
Georgia	Y	Y	Y	Y		
Hawaii	Y	Y	Y	Y		
Idaho	Y	Y	Y	Y		
Illinois	Y	Y		Y		
Indiana	Y	Y	Y	Y		
Iowa	Y	Y	Y	Y		

States	Processing			Stickers		
	In-Person	By Mail	Online	License Plate	Windshield	None
Kansas	Y	Y	Y	Y		
Kentucky	Y		Y	Y		
Louisiana	Y	Y	Y	Y		
Maine	Y		Y	Y		
Maryland	Y	Y	Y	Y		
Massachusetts	Y	Y	Y	Y		
Michigan	Y	Y	Y	Y		
Minnesota	Y	Y	Y	Y		
Mississippi	Y	Y	Y	Y		
Missouri	Y	Y	Y	Y		
Montana	Y	Y	Y	Y		
Nebraska	Y	Y	Y	Y		
Nevada	Y	Y	Y	Y		
New Hampshire	Y			Y		
New Jersey	Y	Y	Y			Y

States	Processing			Stickers		
	In-Person	By Mail	Online	License Plate	Windshield	None
New Mexico	Y	Y	Y	Y		
New York	Y	Y	Y		Y	
North Carolina	Y		Y	Y		
North Dakota	Y	Y	Y	Y		
Ohio	Y		Y	Y		
Oklahoma	Y	Y	Y	Y		
Oregon	Y	Y	Y	Y		
Pennsylvania	Y	Y	Y			Y
Rhode Island		Y	Y	Y		
South Carolina	Y	Y	Y	Y		
South Dakota	Y	Y	Y	Y		
Tennessee	Y	Y	Y	Y		
Texas	Y	Y	Y		Y	
Utah	Y	Y	Y	Y		
Vermont	Y	Y	Y	Y		

States	Processing			Stickers		
	In-Person	By Mail	Online	License Plate	Windshield	None
Virginia	Y	Y	Y	Y		
Washington	Y	Y	Y	Y		
West Virginia	Y	Y	Y	Y		
Wisconsin	Y	Y	Y	Y		
Wyoming	Y		Y	Y		
State Total	49	44	48	45	2	3
District of Columbia	Y	Y	Y		Y	

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CENTER FOR TRANSPORTATION RESEARCH

EXECUTIVE SUMMARY

The University of Texas at Austin

Prepared for the Texas Department of Public Safety

Economic and Safety Considerations: Motor Vehicle Safety Inspections for Passenger Vehicles in Texas

Background

In 2017, the 85th Texas State Legislature passed Senate Bill (S.B.) 2076 with this requirement:

> "Not later than December 31, 2018, the Department of Public Safety and the Texas Department of Motor Vehicles shall:
> (1) conduct a study on the efficiency and necessity of the titling, including actions related to titling such as registration, and inspection of vehicles in this state; and
> (2) submit to the legislature a report on the results of the study that includes:
> a. identification of any elements of the vehicle titling, including actions related to titling such as registration, and inspection programs that can be eliminated; and
> b. recommendations for legislation to eliminate those elements."

S.B. 2076 was signed by Greg Abbott, the Governor of Texas, on June 15, 2017, and became effective September 1, 2017.

The Texas Department of Public Safety (TxDPS), using a competitive selection process, awarded a contract to The University of Texas at Austin's Center for Transportation Research (CTR) to conduct this study.

Study Objectives

The objectives of this study were to meet legislative requirements through these three tasks:

- Quantify the efficiency of the vehicle inspection program by analyzing the economic impacts of eliminating the passenger Motor Vehicle Safety Inspection Program (**referred to in this document as the Inspection Program**) in terms of potential cost and revenue changes for different entities impacted by the program;
- Address the necessity of the Inspection Program by assessing the safety impact of eliminating the Inspection Program on all road users and vehicle owners in Texas; and
- Make recommendations on whether the Inspection Program, as an element of vehicle titling, should be eliminated based on the economic and safety evaluations.

Recommendations

The findings from this study's analysis indicate that the Inspection Program saves lives and enhances safety. The CTR team strongly recommends the following:

- Retain the Inspection Program.
- Conduct a further study to consider whether potential additional inspection items, such as tire age and recall information, should be included in the Inspection Program to further enhance highway safety in Texas.

Please see the full report for all study details, available at this link: www.dps.texas.gov.

Study Methodology

This study undertook a review of current vehicle safety inspection programs worldwide and investigated methodologies to quantify the safety and economic impacts of the Inspection Program. The public's opinions about the Inspection Program were also solicited through surveys of rural and urban areas, a workshop, and stakeholder interviews. Vehicle inspection, registration, and crash databases maintained by TxDPS, the Texas Department of Motor Vehicles, the Texas Department of Transportation, and individual inspection stations were collected and evaluated. CTR used the information obtained from a literature review, public outreach, and an examination of inspection databases to perform the economic analysis and safety impact assessment, determining the potential change to the cost and revenue to vehicle owners, inspection stations, and state agencies, as well as the potential impact on the public in terms of highway safety. The recommendations are based on the economic and safety impact evaluations.

Supporting Conclusions

After conducting a thorough investigation of the costs and safety impacts of eliminating motor vehicle safety inspections for passenger vehicles, the CTR study team identified the salient findings, summarized here, to reach our recommendations.

Safety

- The average crash costs related to vehicles with defects are more than $2 billion per year. Most defects are vehicle elements that would have failed a program inspection.
- The frequency of fatalities, incapacitating injuries, and non-incapacitating injuries is higher for crashes involving vehicles with defects. The number of fatalities per number of defective vehicles in crashes is about three times higher than that of vehicles without defects, as shown in this table:

Passenger vehicles	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Fatalities per number of vehicles in crashes	1 fatality / 98 vehicles	1 fatality / 346 vehicles	1 fatality / 102 vehicles	1 fatality / 341 vehicles	1 fatality / 114 vehicles	1 fatality / 343 vehicles

- Crashes involving vehicles with defects are twice as likely to result in a fatality than crashes with vehicles that do not have defects.
- The most prevalent type of defect related to fatal crashes is slick or defective tires. Interestingly, 23.5% of survey respondents identified slick or defective tires as a vehicle element they had been asked to remedy during the course of their vehicle inspection history—meaning that the fatality crash rate would be higher without such inspections.
- Regarding vehicles from other states that are involved in crashes in Texas, the percentage of vehicles with defects is lower for those states that have vehicle safety inspection requirements than states that do not. This indicates that a safety inspection program helps reduce the number of defective vehicles on the road.
- The percentage of crashes involving defective vehicles increases with higher speed limits—as does the severity of those crashes. Given that Texas has the highest speed limit in the nation and many high-speed roadways, it is important to consider the potential safety impact of eliminating the safety inspection program in Texas on highway safety, especially on roadways with high speed limits.
- Vehicles with defects that were involved in crashes are three years older than the average registered vehicle, which is nine years old. In other words, the percentage of vehicles with defect(s) and had crashes is higher for older vehicles. This highlights the importance of the Inspection Program to help ensure the key components (e.g., tires, brakes etc.) of old vehicles are in good condition.

Changes in Costs and Revenues

The following summary breaks down the allocation of the fees paid for inspections and registration and accounts for other benefits and costs of the program. Note that the costs to vehicle owners cover only the expenses specific to safety-only inspections, as drivers in certain urban counties must continue to obtain yearly emissions testing under federal law. The safety-only inspection fees comprise two components: $7 paid directly to the station operator at the time of inspection and a separate cost paid to the state at the time of vehicle registration.

- **The present Inspection Program represents the following revenue and costs** (where appropriate, these figures are rounded for the convenience of the reader):
  - o The 12,000 station owners, employing 45,000 inspectors, share net revenue of $131 million per year ($7 per inspection).
  - o The State of Texas receives revenue of $150 million per year, offset by $31 million of expenses.
  - o The 19 million vehicle owners' expenses are $307 million in fees to stations and to the State of Texas, as well as time spent getting inspections (approximately $16 per vehicle per year).
- **To discontinue the Inspection Program, the primary parties would incur these costs and savings:**
  - o Station owners would lose net revenue of over $131 million per year.
  - o The State of Texas would lose revenue of approximately $150 million per year and incur a one-time expense of $1 million to discontinue the program.
  - o Vehicle owners would save $307 million (approximately $16 per vehicle per year).
- Fees paid to the state at registration support the Clean Air Fund, the Texas Mobility Fund, and www.Texas.gov; the State of Texas will lose funding for these programs on the order of $39 million, $83 million, and $26 million respectively.
- If the Inspection Program were discontinued, stations in safety-only counties (with no emissions testing, which brings in emissions testing fees) may face closure. This would mean loss of businesses and loss of jobs, and may also severely affect the availability of commercial safety inspections in the state. Given the vital role of freight movement to Texas economy, determining the economic impacts of reducing the number of venues to service the commercial vehicle fleet would present a challenging situation.

Public Perception

Survey analysis resulted in the following programmatic percentages (occurring over the respondents' experience with the Inspection Program) for the four categories of inspection results that were evaluated. Individuals in this group may have had their vehicle inspected over a span of 1 year to approximately 40 years and may have failed an inspection only one time, or up to every time they had their car inspected. Following are the four categories and their percentages:

- 37% of vehicle owners reported that their vehicles never required a replacement part or repair and thus always passed inspection the first time.
- 15.7% of vehicle owners reported that their vehicles never needed a repair or replacement part—however, the station operator observed a defect prior to beginning the inspection and

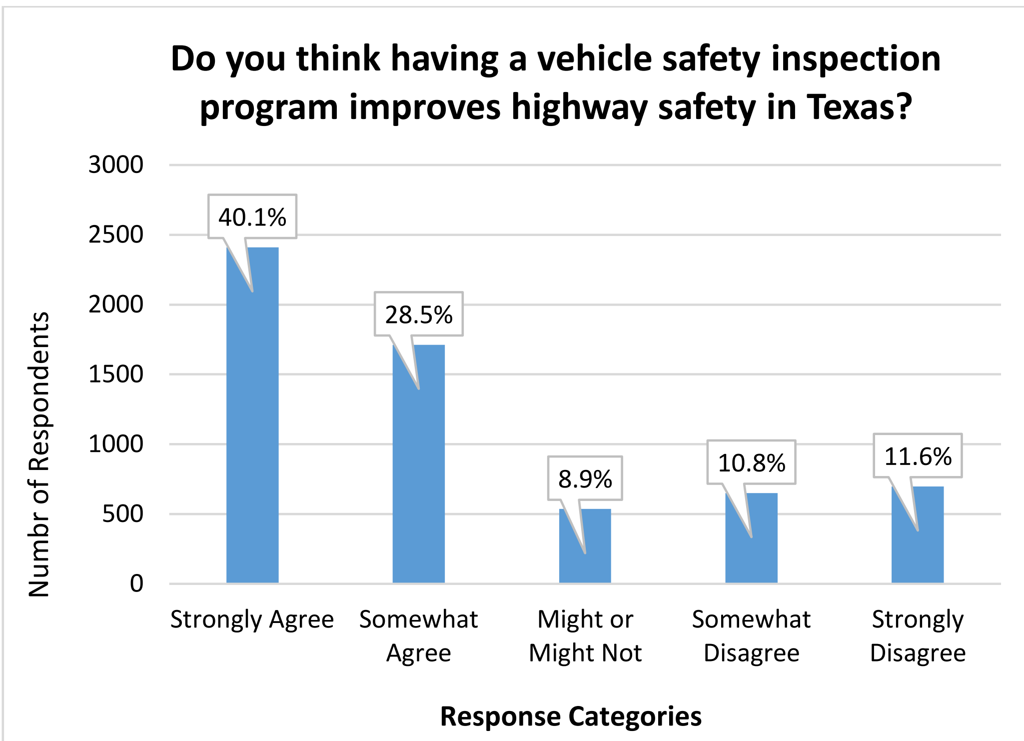
told the owner to have it repaired, then return for an inspection. Thus, this group is counted among those who have had first-time inspection failures.

- 26.5% of vehicle owners reported that the inspection station failed their vehicle, but was able to perform the repairs so that the vehicle could pass inspection.
- 20.8% of vehicle owners reported that the inspection station failed their vehicle, but they went elsewhere for repairs (out of either choice or necessity), then returned to the station for a second inspection before passing.

Thus, 37% of vehicle owners have never failed an inspection and 63% of vehicle owners have failed an inspection at least once over the programmatic time span.

The CTR team used two methods of statistically analyzing the survey data to develop the first-time failure rate: one method provides an estimated range of 7.5% to 12.5% and the other method produces an average of 10.3%.

The results of the study survey indicate that the majority of Texas drivers polled perceive the Inspection Program as a beneficial program, one that enhances highway safety (as the following figure indicates).



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Economic and Safety Considerations: Motor Vehicle Safety Inspections for Passenger Vehicles in Texas

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Report Date:	October 2018
Project Title:	Cost, Revenue and Safety Considerations: Motor Vehicle Safety Inspections for Passenger Vehicles in Texas
Sponsoring Agency:	Texas Department of Public Safety
Performing Agency:	Center for Transportation Research at The University of Texas at Austin

Disclaimers

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Heart of Texas Council of Governments

Deep East Texas Council of Governments

Alamo Area Council of Governments

Texoma Council of Governments

Brownsville Metropolitan Planning Organization

Corpus Christi Metropolitan Planning Organization

Harlingen–San Benito Metropolitan Planning Organization

San Angelo Metropolitan Planning Organization

List of Acronyms and Abbreviations

CMV	commercial motor vehicle
COG	council of government
CRIS	Crash Records Information System – a crash database maintained by TxDOT
CR-3	Crash Record – law enforcement officer crash record report filled out at the crash site. The data from CR-3 reports are used to create the CRIS database.
CTR	The University of Texas at Austin's Center for Transportation Research
FARS	Fatality Analysis Reporting System
MPO	metropolitan planning organization
NHTSA	National Highway Traffic Safety Administration
NSC	National Safety Council
PV	passenger vehicle (vehicle not classified as a commercial vehicle)
TxDPS	Texas Department of Public Safety
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxDIR	Texas Department of Information Resources
TCEQ	Texas Commission on Environmental Quality
TxCPA	Texas Comptroller of Public Accounts
VIC	Vehicle Inspection Connection – equipment used to collect data during a safety inspection and upload the data to the TxDPS Inspection database

Table of Contents

The appendices are provided in a separate file; their titles are listed here for quick reference.

List of Tables

List of Figures

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The findings from this study's analysis indicate that the Inspection Program saves lives and enhances safety. The CTR team strongly recommends the following:

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After conducting a thorough investigation of the costs and safety impacts of eliminating motor vehicle safety inspections for passenger vehicles, the CTR study team identified the salient findings, summarized here, to reach our recommendations.

Safety

- The average crash costs related to vehicles with defects are more than $2 billion per year. Most defects are vehicle elements that would have failed a program inspection.
- The frequency of fatalities, incapacitating injuries, and non-incapacitating injuries is higher for crashes involving vehicles with defects. The number of fatalities per number of defective vehicles in crashes is about three times higher than that of vehicles without defects, as shown in this table:

Passenger Vehicles	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Fatalities per number of vehicles in crashes	1 fatality / 98 vehicles	1 fatality / 346 vehicles	1 fatality / 102 vehicles	1 fatality / 341 vehicles	1 fatality / 114 vehicles	1 fatality / 343 vehicles

- Crashes involving vehicles with defects are twice as likely to result in a fatality than crashes with vehicles that do not have defects.
- The most prevalent type of defect related to fatal crashes is slick or defective tires. Interestingly, 23.5% of survey respondents identified slick or defective tires as a vehicle element they had been asked to remedy during the course of their vehicle inspection history—meaning that the fatality crash rate would be higher without such inspections.
- Regarding vehicles from other states that are involved in crashes in Texas, the percentage of vehicles with defects is lower for those states that have vehicle safety inspection

requirements than states that do not. This indicates that a safety inspection program helps reduce the number of defective vehicles on the road.

- The percentage of crashes involving defective vehicles increases with higher speed limits—as does the severity of those crashes. Given that Texas has the highest speed limit in the nation and many high-speed roadways, it is important to consider the potential safety impact of eliminating the safety inspection program in Texas on highway safety, especially on roadways with high speed limits.
- Vehicles with defects that were involved in crashes are three years older than the average registered vehicle, which is nine years old. In other words, the percentage of vehicles with defect(s) and had crashes is higher for older vehicles. This highlights the importance of the Inspection Program to help ensure the key components (e.g., tires, brakes etc.) of old vehicles are in good condition.

Changes in Costs and Revenue

The following summary breaks down the allocation of the fees paid for inspections and registration and accounts for other benefits and costs of the program. Note that the costs to vehicle owners cover only the expenses specific to safety-only inspections, as drivers in certain urban counties must continue to obtain yearly emissions testing under federal law. The safety-only inspection fees comprise two components: $7 paid directly to the station operator at the time of inspection and a separate cost paid to the state at the time of vehicle registration.

- The present Inspection Program represents the following revenue and costs (where appropriate, these figures are rounded for the convenience of the reader):
  - The 12,000 station owners, employing 45,000 inspectors, share net revenue of $131 million per year ($7 per inspection).
  - The State of Texas receives revenue of $150 million per year, offset by $31 million of expenses.
  - The 19 million vehicle owners' expenses are $307 million in fees to stations and to the State of Texas, as well as time spent getting inspections (approximately $16 per vehicle per year).
- To discontinue the Inspection Program, the primary parties would incur these costs and savings:
  - Station owners would lose net revenue of over $131 million per year.
  - The State of Texas would lose revenue of approximately $150 million per year and incur a one-time expense of $1 million to discontinue the program.
  - Vehicle owners would save $307 million (approximately $16 per vehicle per year).

- Fees paid to the state at registration support the Clean Air Fund, the Texas Mobility Fund, and www.Texas.gov; the State of Texas will lose funding for these programs on the order of $39 million, $83 million, and $26 million respectively.
- If the Inspection Program were discontinued, stations in safety-only counties (with no emissions testing, which brings in emissions testing fees) may face closure. This would mean loss of businesses and loss of jobs, and may also severely affect the availability of commercial safety inspections in the state. Given the vital role of freight movement to Texas economy, determining the economic impacts of reducing the number of venues to service the commercial vehicle fleet would present a challenging situation.

Public Perception

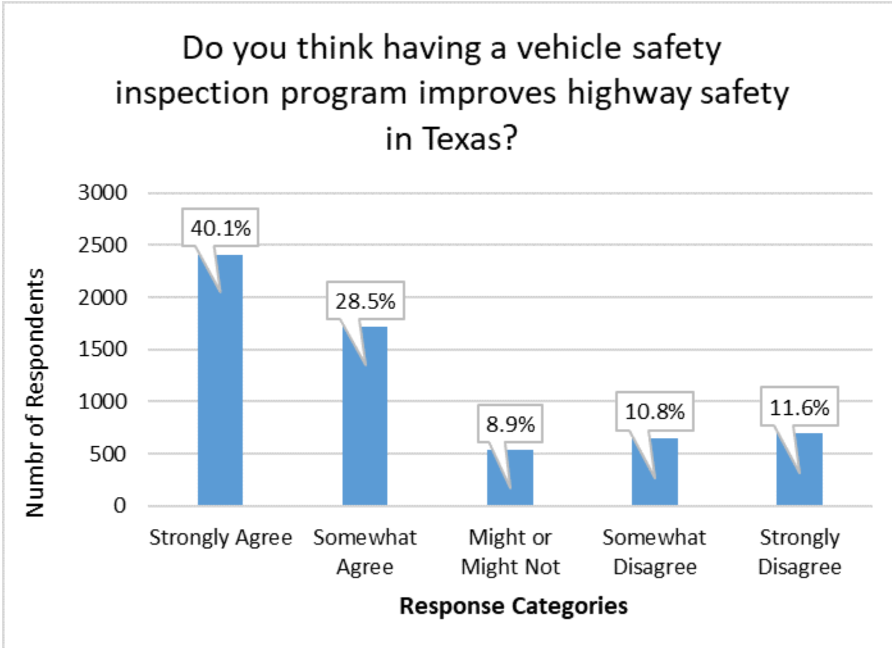
Survey analysis resulted in the following programmatic percentages (*occurring over the respondents' experience with the Inspection Program*) for the four categories of inspection results that were evaluated. Individuals in this group may have had their vehicle inspected over a span of 1 year to approximately 40 years and may have failed an inspection only one time, or up to every time they had their car inspected. Following are the four categories and their percentages:

- 37% of vehicle owners reported that their vehicles never required a replacement part or repair and thus always passed inspection the first time.
- 15.7% of vehicle owners reported that their vehicles never needed a repair or replacement part—however, the station operator observed a defect prior to beginning the inspection and told the owner to have it repaired, then return for an inspection. Thus, this group is counted among those who have had first-time inspection failures.
- 26.5% of vehicle owners reported that the inspection station failed their vehicle, but was able to perform the repairs so that the vehicle could pass inspection.
- 20.8% of vehicle owners reported that the inspection station failed their vehicle, but they went elsewhere for repairs (out of either choice or necessity), then returned to the station for a second inspection before passing.

Thus, 37% of vehicle owners have never failed an inspection and 63% of vehicle owners have failed an inspection at least once over the programmatic time span.

The CTR team used two methods of statistically analyzing the survey data to develop the first-time failure rate: one method provides an estimated range of 7.5% to 12.5% and the other method produces an average of 10.3%.

The results of the study survey indicate that the majority of Texas drivers polled perceive the Inspection Program as a beneficial program, one that enhances highway safety (as the following figure indicates).



Survey responses on the inspection program's role in highway safety

Please reference the full report below for all study details.

Chapter 1. Background and Introduction

This chapter describes the background for this report, the general framework for the study, and the organization of the report chapters and topics.

1.1. Background

In 2017, the 85th Texas State Legislature passed Senate Bill (S.B.) 2076 with this requirement:

> "Not later than December 31, 2018, the Department of Public Safety and the Texas Department of Motor Vehicles shall:
>
> (1) conduct a study on the efficiency and necessity of the titling, including actions related to titling such as registration, and inspection of vehicles in this state; and
>
> (2) submit to the legislature a report on the results of the study that includes:
>
> a. identification of any elements of the vehicle titling, including actions related to titling such as registration, and inspection programs that can be eliminated; and
>
> b. recommendations for legislation to eliminate those elements."

S.B. 2076 was signed by Greg Abbott, the Governor of Texas, on June 15, 2017, and became effective September 1, 2017.

The Texas Department of Public Safety (TxDPS), using a competitive selection process, awarded a contract to The University of Texas at Austin's Center for Transportation Research (CTR) to conduct this study.

The objectives of this study, designed to meet legislative requirements, were to:

- Quantify the efficiency of the vehicle inspection program by analyzing the economic impacts of eliminating the passenger (non-commercial) Motor Vehicle Safety Inspection Program (referred to in this document as the *Inspection Program*) in terms of potential cost and revenue changes for different entities impacted by the program;
- Address the necessity of the Inspection Program by assessing the safety impact of eliminating the Inspection Program on all road users and vehicle owners in Texas; and
- Make recommendations on whether the Inspection Program, as an element of vehicle titling, should be eliminated based on the economic and safety evaluations.

In Texas, vehicle inspection consists of one or two components depending on the location where the vehicle is registered. All vehicles are subject to the Inspection Program and are inspected annually for mandated safety items. The second component is the emission inspection, which is required only for those vehicles in an "emissions county" (currently 17 counties in Texas require enhanced vehicle emissions inspections to improve air quality). Annual inspections are federally mandated under the Clean Air Act (42 U.S.C. 85, subchapter I § 7401 et seq.), and are implemented through the State Implementation Plan. Both programs are administered by TxDPS, in conjunction with the Texas Commission on Environmental Quality (TCEQ). TCEQ's role is to design the emissions component of the program and is the liaison between the state and the U.S. Environmental Protection Agency

This study considers only the Inspection Program and does not include an evaluation of safety inspections for commercial motor vehicles (CMVs) or emissions inspections for any vehicle.

1.2. Study Framework

The study team developed a conceptual framework for the analyses, shown in Figure 1.1, to guide the team's work according to the study scope.

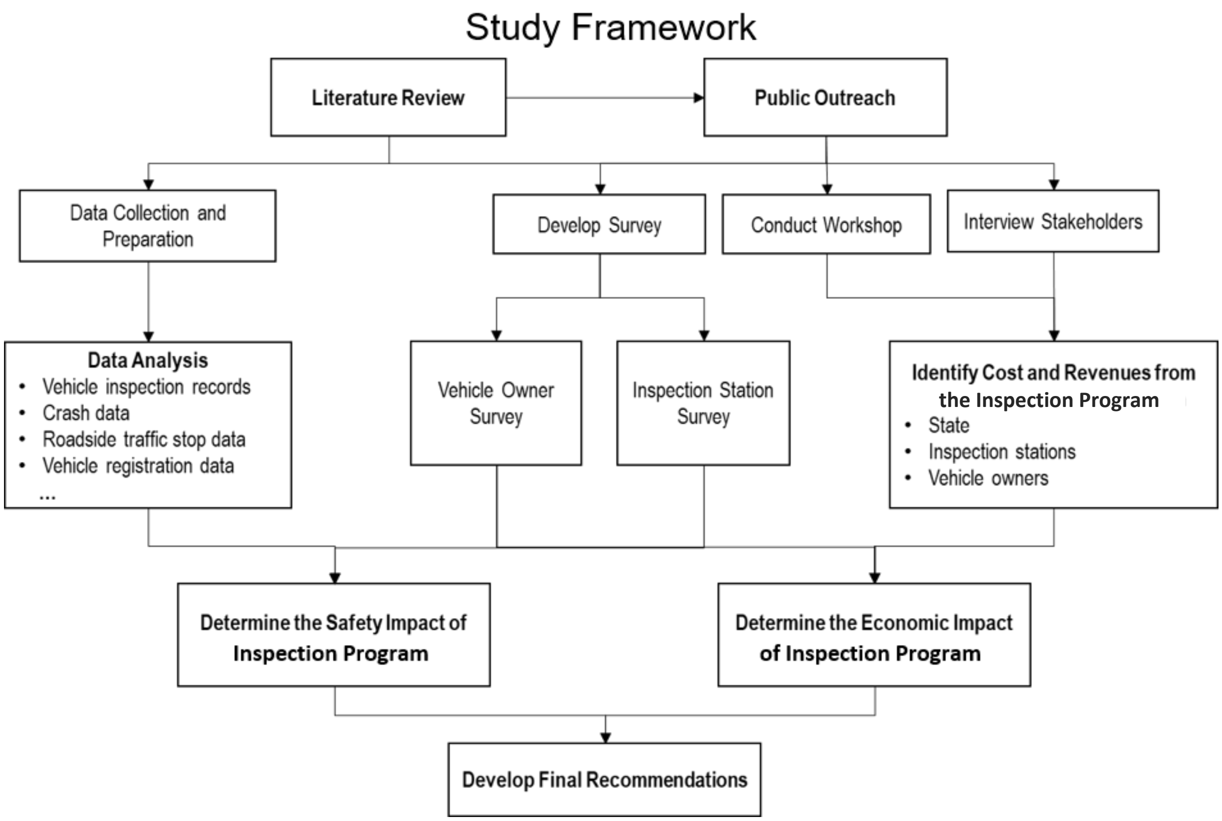


Figure 1.1. A conceptual methodological framework for evaluating the safety and economic impacts of the Inspection Program

As this framework indicates, the study started with a comprehensive literature review and public outreach. The literature review served as the basis of the study and provided useful information throughout the research duration. Based on the information gathered from the literature review and other sources, the study team developed a plan for public outreach. This included conducting a survey of vehicle owners and inspection station owner/operators, holding a stakeholder workshop, and interviewing stakeholders to gather information from the public regarding their opinions about the Inspection Program in Texas.

With information obtained from the literature review and public outreach, the study team identified important data sources for the safety and economic analysis. The data analysis started with collecting, examining, and preparing the data. The major data sources used in this study include the statewide vehicle inspection database, crash database, roadside traffic citation database, vehicle registration database, and vehicle inspection records from individual vehicle inspection stations. These datasets were carefully analyzed using various data analysis techniques, such as comparative analysis, statistical analysis, etc. These data analysis results and meaningful insights gained from analyzing vehicle owner and inspection station survey responses formed the basis for determining the safety impact of the Inspection Program in Texas.

Information obtained from the literature review and public outreach also fed into the economic analysis component of this study, allowing the cost and revenues related to the Inspection Program to be evaluated from the perspectives of the inspection stations, the state, and vehicle owners. This analysis led to the economic impact evaluation produced by this study.

Finally, based on the major findings obtained from the safety impact and economic impact assessments, the study team developed the final recommendations regarding whether the Inspection Program should be either continued or eliminated.

1.3. Organization of the Report

To present the information most pertinent to the study objectives of the study, this report is organized into the following six chapters (with extensive supporting materials provided in the appendices):

- **Chapter 2. Cost and Revenue Analysis**

  The team researched and developed a detailed accounting for the inspection fees and licensing structure to address the primary affected parties: the station owners/inspectors, the State of Texas, and the vehicle owner. Section 2.1 summarizes the economic analysis for the present Inspection Program and outlines the effects should the Inspection Program be discontinued. Section 2.2 describes additional considerations discovered during the course of the economic investigation. The full economic evaluation is detailed in Appendix A.

- **Chapter 3. Safety Impact Assessment**

  This chapter presents the major findings from assessing the program's safety impact using various data sources, which include, for example, the economic and comprehensive costs arising from crashes involving vehicles with defects, a comparison between crashes involving vehicles with and without defects, an assessment of crashes in Texas involving out-of-state vehicles from states with and without inspection programs, and identification of major defect types found on vehicles that had crashes. Supporting details of each major finding are presented in this chapter and relevant appendices.

- **Chapter 4. Literature Review**

  In this chapter, the CTR team synthesizes a comprehensive literature review. Section 4.1 presents the current practices of inspection programs in Texas, other U.S. states, and other countries. Section 4.2 examines literature on the involvement of vehicle defects in crashes and the safety effectiveness of inspection programs, including the data and methodologies used for evaluating the safety and economic impacts of inspection programs. Major findings from the literature review are summarized in Section 4.3. More details, including a review of each citation, are provided in Appendix G.

- **Chapter 5. Public Outreach**

  Public outreach was needed to understand the industry stakeholders' and the public's perception of the existing Inspection Program and the direction these groups thought it should take. This chapter discusses the project's public outreach activities:

  - Stakeholder interviews (Section 5.1)
  - Stakeholder workshop (Section 5.2)
  - Vehicle owner survey (Section 5.3)
  - Inspection station survey (Section 5.4)
  - First-time failure rates (Section 5.5)

  This chapter analyzes the interview and survey results, summarizing important findings from these public outreach activities.

- **Chapter 6. Inspection Database Examination**

  Section 6.1 summarizes major findings from examining the statewide inspection database. Section 6.2 spotlights a specific inspection dataset to closely examine and contrast 714 inspection records for Houston taxis and limousines. Information such as first-time failure rate, average mileage, average number of failure reasons, and detailed summary on defective items are presented and analyzed using both Houston inspection program standards and the Inspection Program standards. Detailed analyses of both standards are provided in Appendix L. Section 6.3 examines the Texas Highway Patrol High Value Dataset Database for citations and warnings for vehicles stopped and found to have safety defects.

- **Chapter 7. Conclusions and Recommendations**

  The last chapter summarizes the study activities and major conclusions and provides the study team's final recommendations.

Chapter 2. Economic Impact Analysis

To conduct the economic analysis one needs a clear understanding of the revenue and expense structure of the Inspection Program relevant to 1) the vehicle inspection stations, 2) the Texas state budget, and 3) the vehicle owners. Delineating the revenues and expenses for various parties is complicated, for either continuing or discontinuing the Inspection Program. There are one-time expenses as well as aggregate program revenues and expenses, and there would be a loss of existing revenue to support various programs if the program were discontinued. The CTR team has attempted to identify and account for them as best as possible using 2017 or the most current data. Below is a summary of that analysis and the additional considerations discovered during the analysis. The full details of the economic evaluation appear in Appendix A.

2.1. Summary of Economic Analysis

The present Inspection Program represents the following revenue and costs:

- Station Owners and Inspectors
  - Revenue: $137,276,594 per year ($7 per inspection)
  - Expenses: $6,461,566 per year
  - Net revenue of approximately $131 million per year
- State of Texas
  - Revenue: $149,577,760 per year
  - Expenses: $31,204,253 per year
  - Net revenue of approximately $118 million per year
- Vehicle Owners
  - Expenses: $307,314,925 per year (approximately $307 million per year for the 19 million vehicle owners, or $16 per vehicle per year.)

To discontinue the Inspection Program, the primary parties would incur these costs and savings:

- Station Owners and Inspectors
  - Revenue: $0 - This represents a loss of $137,276,594 per year.
  - Expenses: $0
- State of Texas
  - Revenue: $0 - This represents a loss of $149,577,760 per year.
  - Expenses: $1,033,480 (one-time expense)
- Vehicle Owners
  - Expenses: $0

2.2. Additional Considerations

These additional considerations may factor into a legislative decision:

- None of the current fees paid to the state at registration are directed to TxDPS to administer the program.
- Inspection Program fees paid to the state, collected at registration, go to support the Clean Air Fund and the Texas Mobility Fund; these programs will receive less funding on the order of $39 million and $83 million respectively. Discussions with TCEQ indicated that the current fees account for approximately 33% of funding for the Clean Air Fund.
- The Texas Department of Information Resources (TxDIR) pointed out that Texas.gov fees collected with most of the transactions help support all the functions of www.Texas.gov as well as the safety inspection equipment deployment and troubleshooting. Loss of these fees would require replacement funding in some form. Currently this is approximately $26 million.
- If the Inspection Program were discontinued, there may not be enough commercial business to keep 12,000 inspection stations open to conduct only commercial safety inspections. Those stations in safety-only counties (with no emissions testing that brings in emissions testing fees) may face closure. This would mean loss of businesses and loss of jobs, and may also severely affect the availability of commercial safety inspections in the state.

Chapter 3. Safety Impact Analysis

This chapter presents the major findings from analyzing the safety impact of the Inspection Program. The ultimate goal of the analysis was to evaluate whether eliminating the Inspection Program could affect highway safety in Texas.

Data from various sources were collected, examined, and pre-processed in preparation for the analysis. These datasets—combined with useful information obtained from the literature review, workshop, stakeholder interviews, and surveys—formed the basis of the analysis. These three major data sources were used in this analysis:

- TxDOT Crash Records Information System (CRIS) Data (2010–2017)
- TxDPS "Texas Highway Patrol High Value Data Sets" (Roadside Traffic Stop – Citation Data, 2010–2016)
- TxDMV – Vehicle Registration Data (2015–2017)

Appendix B details the preparation and preprocessing of these data sets for the safety impact study (e.g., the method used to identify vehicles with defects within the crash data sets).

Safety Impact Analysis Major Finding 1

The average crash costs arising from vehicles with defects being involved in fatal, incapacitating-injury, and non-incapacitating-injury crashes are more than $2 billion per year, based on crashes occurring 2015–2017 and using TxDOT's Highway Safety Improvement Program crash costs.

Using the method described in Appendix B, the study team was able to identify vehicles with defects that were involved in crashes in Texas. Table 3.1 provides the statistics for crashes involving vehicles with defects by crash severity type from 2015 to 2017.

Table 3.1 Number of crashes involving vehicles with defects

Crash Severity Type	2015		2016		2017	
	PV	CMV	PV	CMV	PV	CMV
Fatal	85	31	92	23	87	21
Incapacitating Injury	308	38	364	46	343	44
Non-Incapacitating Injury	1,167	111	1,294	127	1,402	146
Possible Injury	1,573	159	1,801	123	1,767	144
Not Injured	6,220	734	6,934	734	6,808	885
Unknown	177	4	199	3	213	7
Total	**9,530**	**1,077**	**10,684**	**1,056**	**10,620**	**1,247**

PV: passenger vehicles and other non-commercial vehicles. CMV: commercial motor vehicles

On average, about 88 fatal crashes, 338 incapacitating-injury crashes, and 1288 non-incapacitating-injury crashes happened in Texas each year that were caused or potentially caused by PV defects.

The following crash costs were used by TxDOT when developing highway safety improvement programs (TxDOT, 2018). According to the TxDOT Highway Safety Improvement Program Manual, the average cost of each type of crash is based on modifications to the comprehensive cost figures provided by the National Safety Council (NSC) (TxDOT, 2015). NSC's comprehensive crash costs include wage and productivity losses, medical expenses, administrative expenses, motor-vehicle damage, uninsured employer costs, and the value of lost quality of life associated with deaths and injuries.

- Fatal crash: $3,500,000 per crash (regardless of the number of fatalities)
- Incapacitating-injury crash: $3,500,000 per crash (regardless of the number of incapacitating injuries)
- Non-incapacitating-injury crash: $500,000 per crash (regardless of the number of non-incapacitating injuries)

Using these crash costs, the total costs of these crashes involving vehicles with defects were calculated and are shown in Table 3.2.

Table 3.2 Costs of crashes involving vehicles with defects using TxDOT crash costs

	2015	2016	2017
PV	$1.96 billion	$2.24 billion	$2.21 billion
CMV	$0.30 billion	$0.31 billion	$0.30 billion
Total	**$2.26 billion**	**$2.55 billion**	**$2.51 billion**

The NSC's crash economic calculations, which use different crash categories and costs, produce similar but higher overall total costs. These calculations can be found in Appendix C.

Regardless of the crash cost calculations used, the analysis shows that the crashes involving vehicles with defects can cause significant safety, economic, and societal impacts to the state.

Safety Impact Analysis Major Finding 2

The frequency of fatalities, incapacitating injuries, and non-incapacitating injuries is higher for crashes involving vehicles with defects. Defect-vehicle-related crashes are twice as likely to result in a fatality than crashes with vehicles that have no defects.

The study team compared vehicles with and without defects, and crashes involving vehicles with and without defects, with the goal of identifying whether significant differences exist.

Table 3.3 lists the number of fatalities per number of PVs in crashes. As the data shows, the number of fatalities per number of defective vehicles in crashes is about three times higher than that of vehicles without defects. In other words, if the same number of vehicles with and without defects are involved in crashes, the possibility of a fatality occurring is higher when vehicles have defects.

Table 3.3 Numbers of fatalities and crashes for PVs with and without defects

PV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of fatalities	100	2,925	108	3,171	96	3,070
Number of vehicles in crashes	9,847	1,013,141	11,131	1,080,797	10,972	1,055,040
Fatalities per number of vehicles in crashes	**1 fatality / 98 vehicles**	**1 fatality / 346 vehicles**	**1 fatality / 102 vehicles**	**1 fatality / 341 vehicles**	**1 fatality / 114 vehicles**	**1 fatality / 343 vehicles**

The study team also compared the percentage of vehicles involved in fatal crashes among all vehicles, examining the categories of vehicles with or without defects. As shown in Figure 3.1, the 2015, 2016, and 2017 data all show that the percentage of fatal crashes among all crashes is higher for PVs with defects than PVs without defects. In other words, if we separate all vehicles involved in crashes each year in the CRIS database into two groups—one group with defects and another group without—the percentage of vehicles involved in fatal crashes is higher for the group of vehicles with defects.

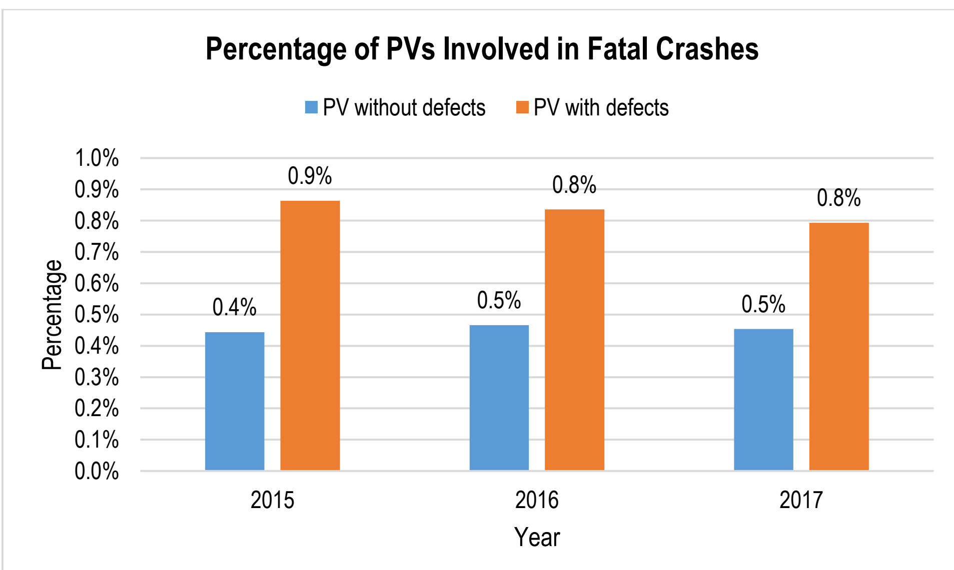


Figure 3.1. Percentage of PVs with or without defects involved in fatal crashes

Similar trends to those described in Table 3.4 and Figure 3.1 are observed with CMVs and both incapacitating and non-incapacitating injuries (see Appendix D for more details).

Safety Impact Analysis Major Finding 3
Defective or slick tires are the most prevalent type of defect related to fatal crashes. However, slick tires are not often detected by law enforcement officers during roadside stops, indicating the necessity of periodic professional inspections.

The study team analyzed the types of defects that law enforcement officers believe have or may have contributed to a crash, with the goal of identifying the major defect types and whether they are preventable by vehicle safety inspection.

Figures 3.2 and 3.3 show the analysis results for PVs and CMVs respectively[1]. The most frequently occurring type of defect for vehicles involved in all types of crashes (blue bars in Figure 3.2) are "Defective or Slick Tires" (33%) and "Defective or No Vehicle Brakes" (25%). In comparison, more than 70% of defective vehicles involved in fatal crashes (orange bars) have "Defective or Slick Tires." This finding indicates that problematic tires are a primary contributor to severe PV crashes related to vehicle defects.

"Defective or Slick Tires" (37%) and "Defective or No Vehicle Brakes" (18%) are also top defects for CMVs (blue bars in Figure 3.3). However, compared with the 70% of PVs, about only 30% of defective CMVs involved in fatal crashes have defective or slick tires (orange bars in Figure 3.3). More than 50% of them have other types of problems.

These defect type analyses indicate the importance of having well-functioning tires and brakes, especially for PVs. Checking these parts regularly is expected to help prevent some of these crashes, especially severe crashes.

[1] The defect type "Other (Explain In Narrative)" shown in these figures means the vehicle exhibited a type of defect that is rarer than the other types listed, such as these examples: lost tire, wheel/tire came off, mechanical failure (no specific reasons provided), vehicle malfunction (no specifics), possible brakes malfunction (cannot verify due to vehicle damage condition).

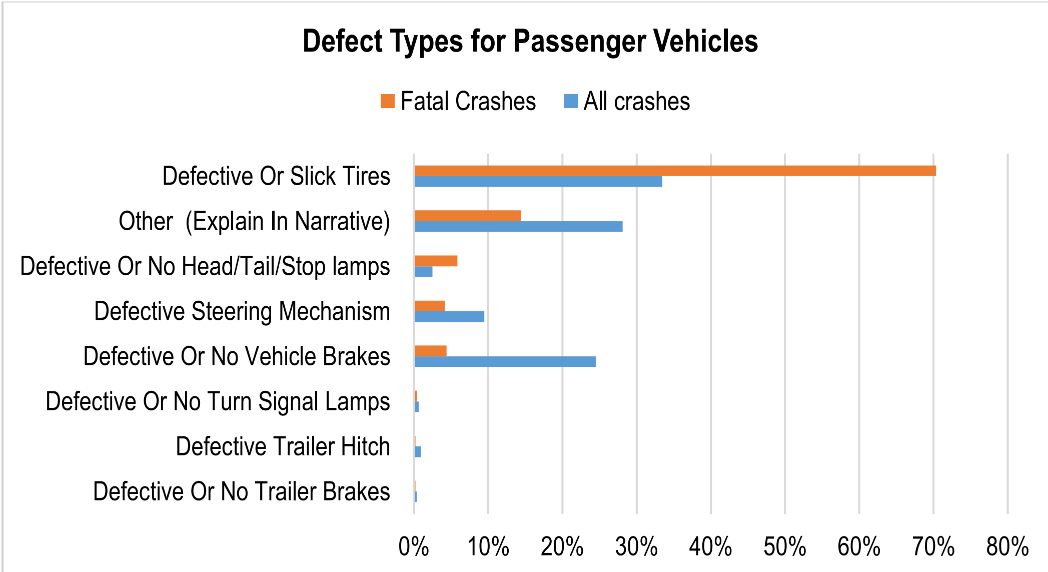


Figure 3.2. Types of defects for PVs

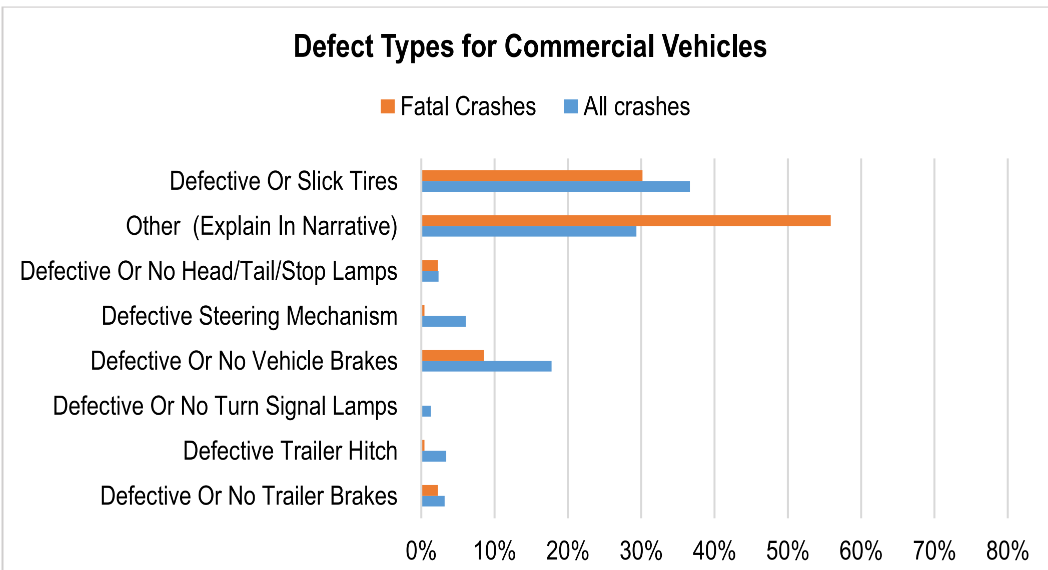
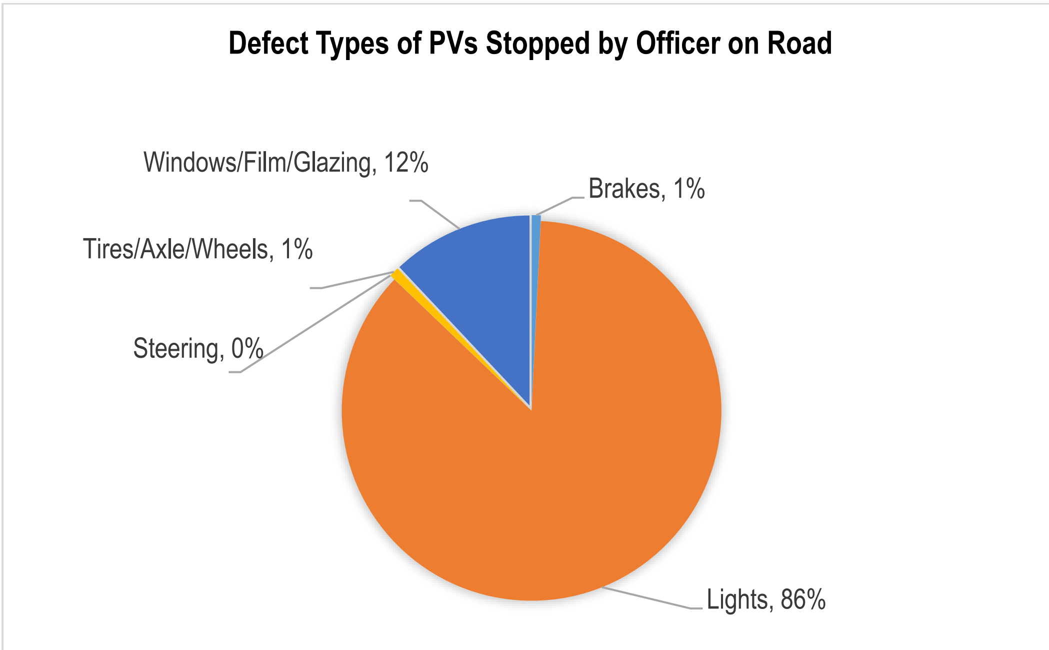


Figure 3.3. Types of defects for CMVs

The TxDPS citation data also stores information about the defect types of those defective vehicles stopped by law enforcement officers. The study team found that 53% of stopped CMVs and 10% of stopped PVs have one or more types of following defects:

- Brakes
- Lights
- Steering
- Tires/Axle/Wheels
- Windows/Film/Glazing

When comparing the defect types of PVs stopped by officers on the roadside to those of PVs involved in fatal crashes (see Figure 3.4), the study team found that even though less than 1% of vehicles stopped on the roadside have tire problems, almost 70% of those defective vehicles involved in fatal crashes have defective or slick tires. This difference shows that some types of vehicle defects are difficult to capture by law enforcement officers at roadside stops—yet these defects could cause severe crashes.



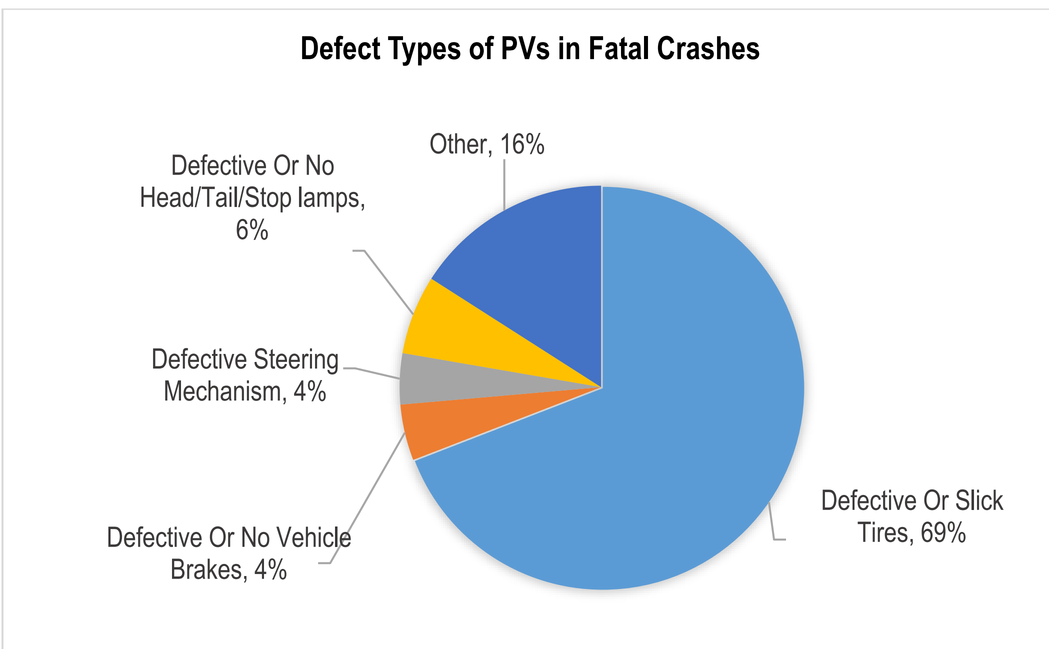


Figure 3.4. Defect types of PVs stopped on the roadside and PVs in fatal crashes

Safety Impact Analysis Major Finding 4

Regarding vehicles from other states that are involved in crashes in Texas, the percentage of vehicles with defects is lower for those states that have vehicle safety inspection requirements than states that do not. This indicates that a safety inspection program helps reduce the number of defective vehicles on the road.

For all crashes in Texas, the TxDOT crash database stores information about the U.S. state or other country in which the vehicles are registered (based on the license plates). The study team calculated the percentage of defective vehicles among all vehicles for all the U.S. states observed in the dataset. The average percentage from 2010 to 2017 for each state is used to compare states on the basis of whether they require PV safety inspections. Tables E.1 and E.2 in Appendix E list the number of all PVs and the subset of defective PVs that had crashes in Texas each year from 2010 to 2017, respectively for the home states that require and do not require vehicle safety inspections.

The average percentage of defective vehicles from states that do not require PV safety inspection is 0.83%; the percentage from states requiring PV safety inspection is 0.61%. On average, the states that do not require PV safety inspection have a higher percentage of defective vehicles. To test if this difference between these two groups of states is significant, the study team performed a t-test, which is a statistic test often used to test if the means of two samples are equal. The full statistical test results are shown in Appendix F.

The test results show that the P-value (0.01) is smaller than 0.05. This means we can conclude that, with 95% confidence, the percentage of defective vehicles from states with and without passenger safety inspection requirement is significantly different. The conclusion is that vehicle safety inspection programs reduce the number of defective vehicles.

Safety Impact Analysis Major Finding 5

The analysis of the relationship between crashes and speed limit shows that the percentage of crashes involving defective vehicles increases with higher speed limits—as does the severity of those crashes. Given that Texas has the highest speed limit in the nation and many high-speed roadways, it is important to consider the potential safety impact of eliminating the Inspection Program in Texas on highway safety, especially on roadways with high speed limits.

The study team examined the relationship between speed limit and number and severity of crashes, considering the high speed limits found in Texas.

As shown in Figure 3.5, the overall number of crashes per million vehicle miles traveled (VMT) does not increase much as the speed limit rises, once the speed limit is greater than 45 mph. However, the percentage of crashes with defective PVs increases dramatically with the increase in speed limit, especially when the speed limit is greater than 60 mph. This indicates that defective vehicles are more likely to have crashes on roadways with higher speed limits. This is understandable. If a driver is operating a vehicle with defective brakes or tires, should an unexpected event requiring evasive maneuvers or braking occur while the vehicle is at a lower speed, the driver may still be able to react and take actions to avoid a crash. However, this would be much more difficult at a high speed.

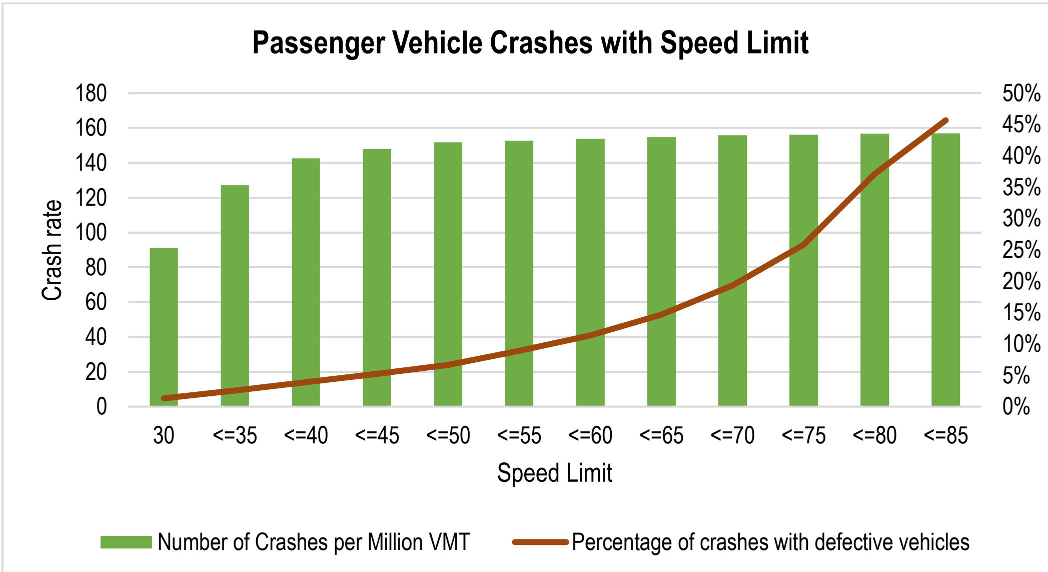
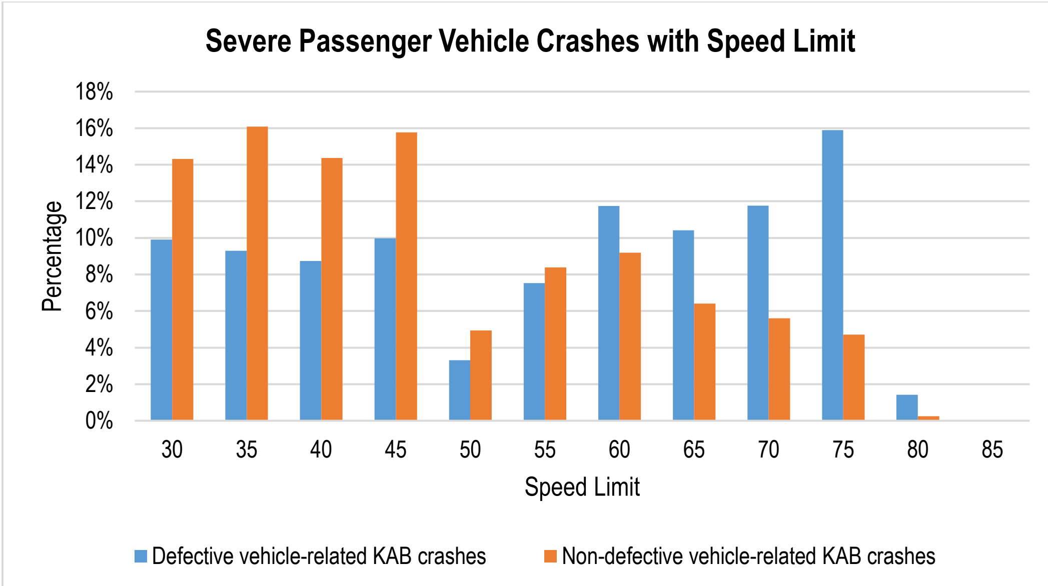


Figure 3.5. Relationship between PV crash rate and percentage of crashes involving defective PVs with speed limit

Not only do a higher percentage of defective-vehicle-related crashes happen on roadways with higher speed limits, the severity of crashes increases with speed limit as well. As shown in Figure 3.6, when the speed limit is lower than 60 mph, the percentage of severe crashes (i.e., fatal, incapacitating-injury, and non-incapacitating-injury crashes—often referred to with the term "KAB," in which K refers to fatalities, A to incapacitating crashes, and B to non-incapacitating crashes) among all crashes for non-defective vehicles is higher than that for defective vehicles. However, when the speed limit is equal to or higher than 60 mph, the percentage of severe crashes among all crashes for vehicles with defects is much higher than vehicles without defects.



(Note: KAB is a severity measure that represents fatalities [K], incapacitating-injury crashes [A], and non-incapacitating-injury crashes [B])

Figure 3.6. Relationship between PV KAB crashes with speed limit

Based on TxDOT Pavement Management Information System 2015 data provided by TxDOT, Texas has over 118,000 lane miles of roadways with speed limits equal to or higher than 60 mph and carrying over 340 million VMT per day. Texas is also the only state that has speed limits as high as 85 mph. Because Texas has such high speed limits and such an extensive network of those high-speed roadways, given the relationship between speed limit and defective PV crashes it is important to have a program help to reduce the number of defective vehicles on Texas roadways.

Safety Impact Analysis Major Finding 6

Vehicles with defects that were involved in crashes are three years older than the average registered vehicle, which is nine years old. The percentage of vehicles with defects that had crashes is higher for older vehicles. This highlights the importance of the Inspection Program's role in ensuring that the vital components (e.g., tires, brakes, etc.) of old vehicles are in good condition.

Based on information about vehicle model year obtained from vehicle registration data and from TxDOT's CRIS database, the study team calculated for 2015–2017 the average model year of all vehicles registered in Texas, all vehicles involved in crashes in Texas, and all defective vehicles involved in crashes in Texas. The results are shown in Table 3.4. The average age of PV with defects that had crashes are three years older than the average vehicle. This is as expected, since older cars tend to have more defects due to wear and tear.

Table 3.4 Average vehicle age (years)

	All vehicles	Vehicles in crashes	Defective vehicles in crashes
PV	9	8	12
CMV	9	8	11

The blue columns in Figure 3.7 represent the number of defective PVs involved in crashes in 2017 with different vehicle ages. The orange line shows the percentage of these vehicles among all vehicles registered in 2017 with the same vehicle age.

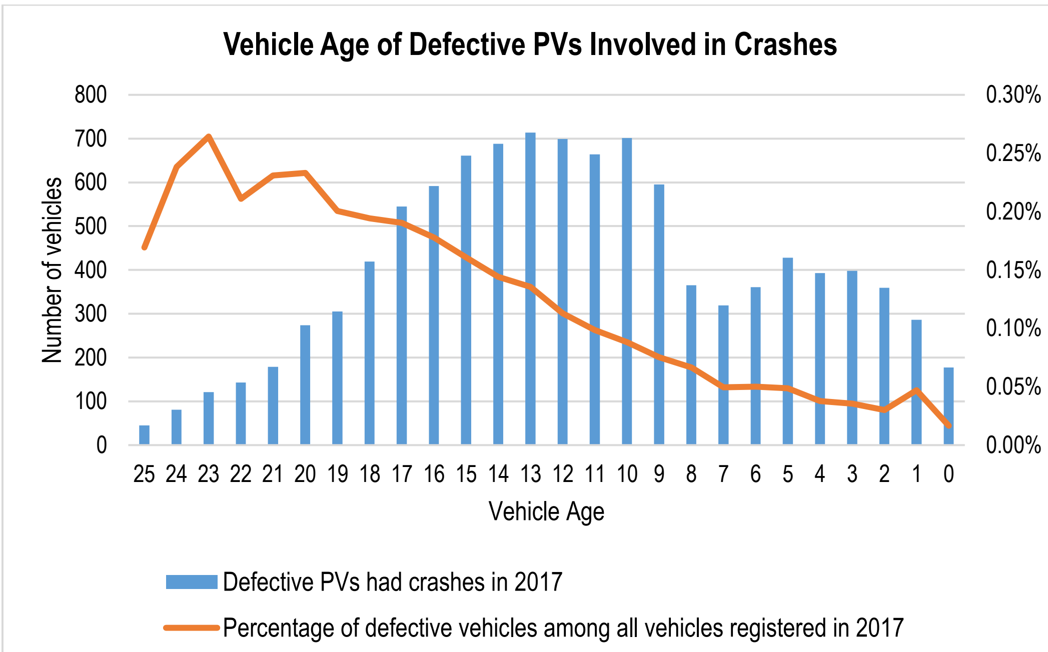


Figure 3.7. Vehicle age of defective vehicles involved in crashes in 2017

As shown in Figure 3.7, more vehicles between 10 to 15 years old had defects and were involved in crashes. This matches with the average age of vehicles with defects that were involved in crashes (12 years old) shown in Table 3.4.

The percentage of vehicles with defects that had crashes among all registered vehicles with the same age decreases as vehicles get younger, as demonstrated by the orange line in Figure 3.7. This shows that older vehicles are more likely to have both defects and crashes.

Safety Impact Assessment Major Finding 7

Younger drivers are disproportionately involved in defect vehicle crashes. The average age of drivers of defective vehicles that had crashes was 34, while the average driver involved in all crashes was 38, and the average licensed driver in Texas is 46.

Based on FHWA data, the average age of Texas-licensed drivers in 2016 was 46 years. (Please see Appendix D for data source and calculations.)

Considering the 2016 crash data, the study team found that the average driver age of all PVs involved in crashes was 38 and that the average driver of PVs with defects and crashes was 34. Drivers of defective PVs that have had crashes were 12 years younger than the average driver in Texas.

The 4–to-5-years age difference between drivers of PVs without defects and PVs with defects is also apparent when assessing separately the crashes with different severity types, as shown in Figure 3.9.

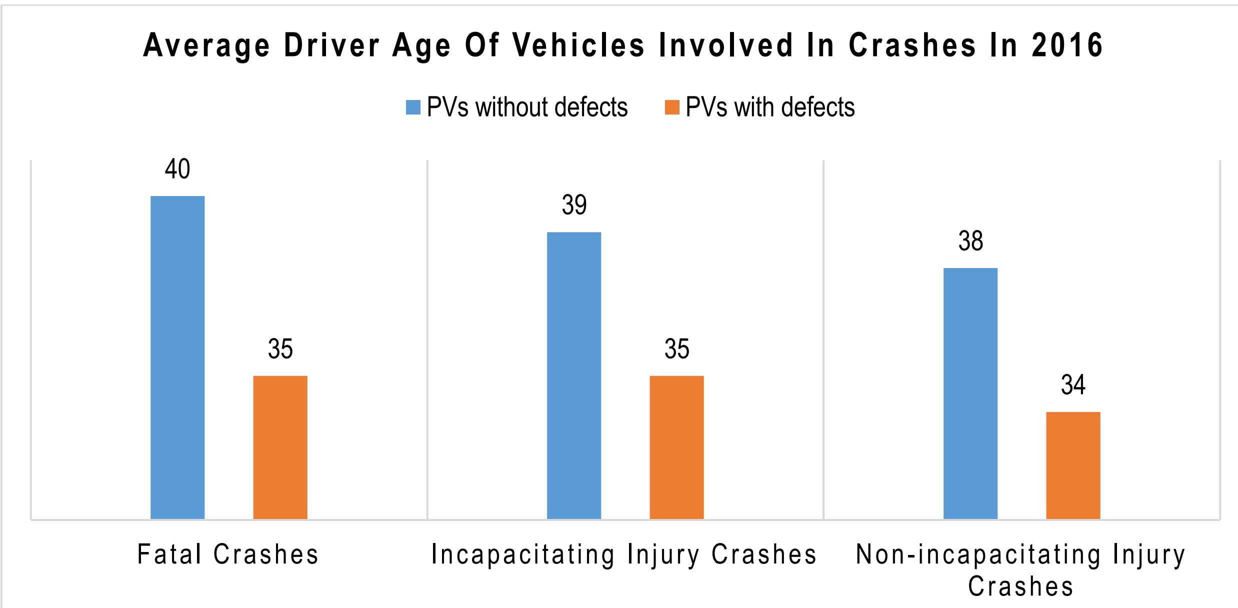


Figure 3.9. Average driver age of PVs involved in crashes with different severity levels in Texas in 2016

Figure 3.10 shows the percentage of PV drivers by age group who were involved in defect or non-defect vehicle crashes, using 2016 crash data. It is obvious that drivers of defect vehicles are more concentrated in those younger age groups. This is consistent with the previous statement that the average age of defective vehicle drivers is younger than that of non-defective vehicle drivers. We observe the same trend exhibited in Figure 3.10 if only fatal, incapacitating, and non-incapacitating crashes are considered.

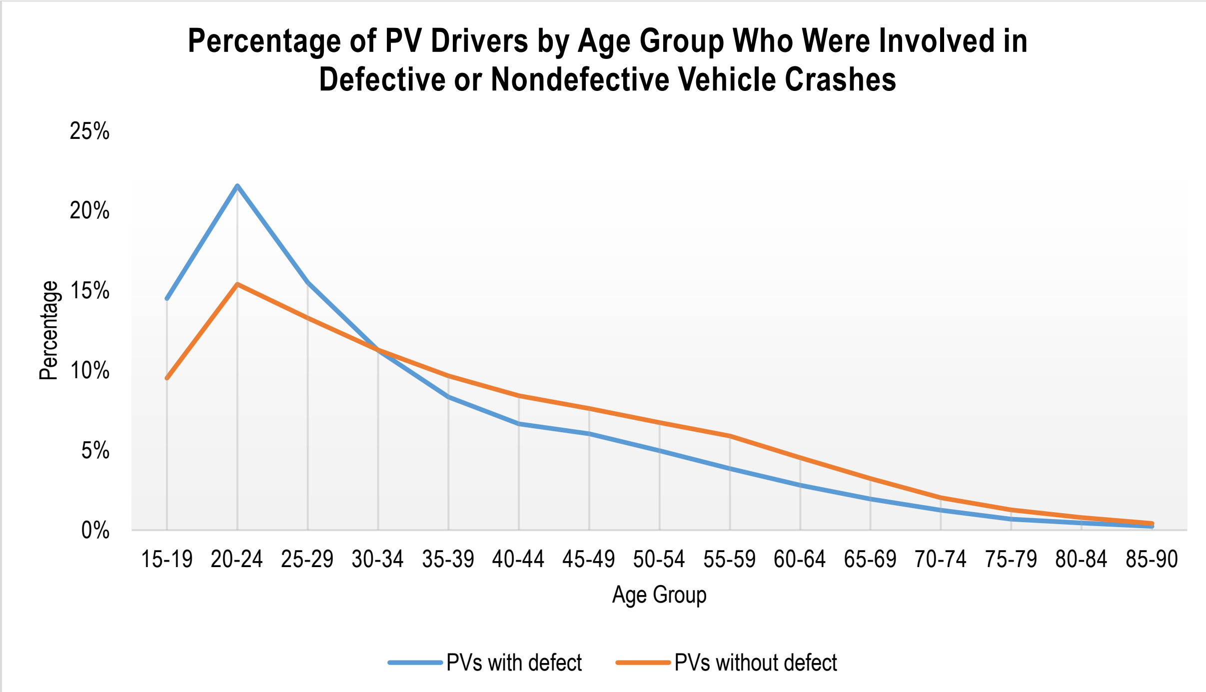


Figure 3.10. Percentage of defective PV drivers out of all drivers of PV involved in crashes in Texas in 2016

This analysis indicates that drivers younger than 30 are disproportionately involved in all vehicle crashes and especially defect vehicle crashes. While younger driver have less experience, defect vehicles add another element of risk, resulting in even more involvement in crashes.

As shown in Table 3.4, defective vehicles in crashes are three years older than the average Texas-registered vehicle. Looking at the 2016 crash data specifically, the PVs with defects involved in fatal, incapacitating, and non-incapacitating injury crashes are also three to four years older than those vehicles without defects, as shown in Figure 3.11.

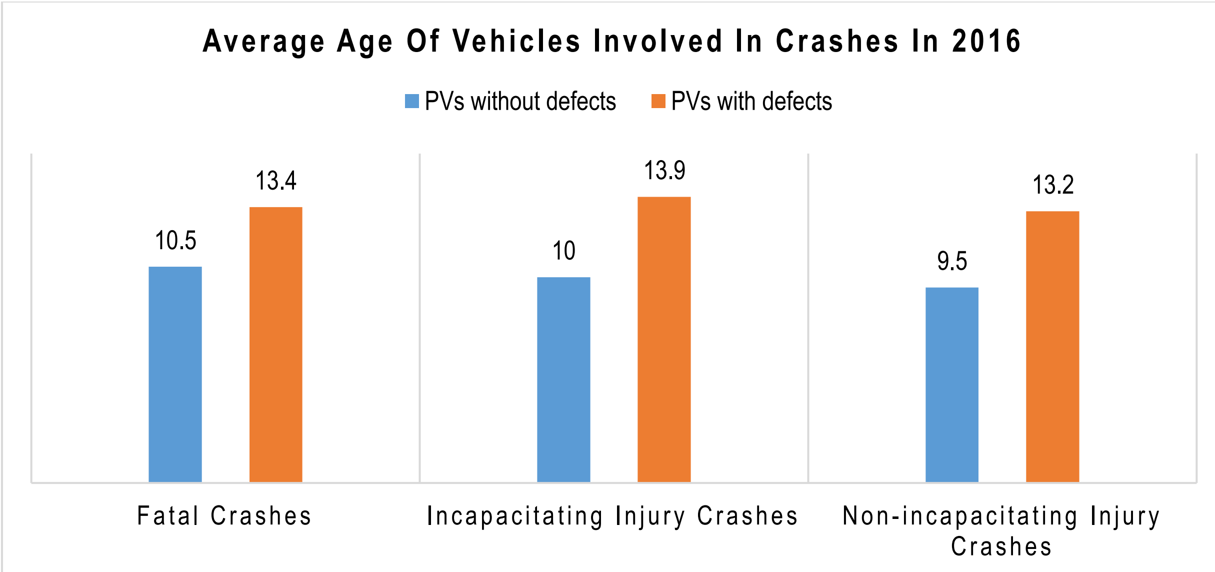


Figure 3.11. Average age of PVs involved in crashes in Texas in 2016

In addition, based on a study conducted by the National Highway Traffic Safety Administration (NHTSA, 2013), there is a higher risk of fatalities in older vehicles due to fewer safety features. Thus, eliminating the safety inspection program may increase the risk of injury or death for younger drivers and drivers of older vehicles with defects.

Chapter 4. Literature Review

This chapter synthesizes a comprehensive literature review, providing the current inspection program practices of Texas, other U.S. states, and some major countries around the world. The study team also reviewed extensive literature examining the involvement of vehicle defects in crashes and the effectiveness of inspection programs in terms of crash reduction.

4.1. Inspection Program Practices

In Texas, vehicle inspection consists of one or two components, depending on the location where the vehicle is registered. All vehicles are subject to the Inspection Program and are inspected annually for safety items. The potential second component is the emission inspection, which is required only for those vehicles in emissions counties (currently 17 counties) for gasoline-powered vehicles that are model age 2 to 24 years. Annual emissions inspections are mandated by the TCEQ, but both programs are managed by TxDPS.

For a regular PV, the following items will be inspected during the annual safety inspection: horn, windshield wipers, mirror, steering, seat belts, brake system (parking—beginning with 1960 models), tires, wheel assembly, exhaust system, exhaust emission system (beginning with 1968 models), beam indicator (beginning with 1948 models), tail lamps, stop lamps, license plate lamp, rear red reflectors, turn signal lamps (beginning with 1960 models), head lamps, gas caps on vehicles 2 to 24 model years old, window tint; and the motor, serial, or vehicle identification number. The costs of the Inspection Program are summarized in Chapter 2 and fully detailed in Appendix A.

The study team also investigated how other U.S. states and the District of Columbia perform vehicle inspection programs. Four states have only safety inspection programs. Eighteen states (including the District of Columbia) operate only emission inspection programs. Fourteen states maintain both safety inspection and emission inspection programs. The other 15 states do not have either a state inspection program or emission inspection program. In other words, a total of 18 states maintain a state safety inspection program and 32 states operate a state emission inspection program. Figure 4.1 presents vehicle inspection program types by state.

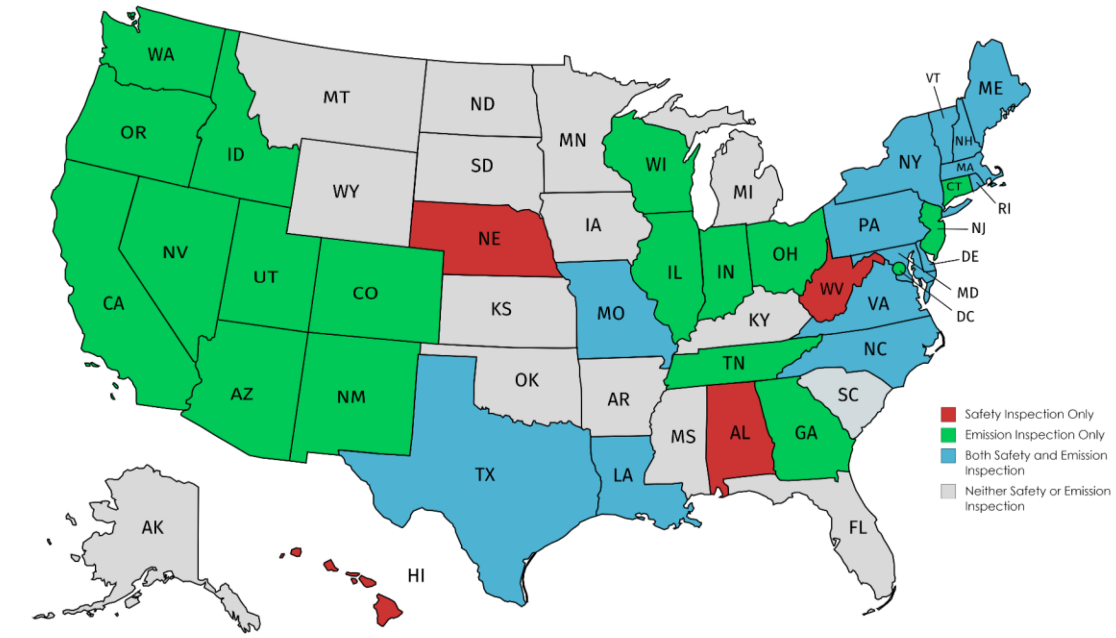


Figure 4.1. Vehicle inspection program types by state

More detailed information on vehicle inspection programs in other U.S. states is provided in Appendix G.1. In addition, the study team examined the vehicle inspection program practices in other major countries. Different vehicle components are checked and different tests are performed in order to evaluate a vehicle's risk for crash and contribution to emissions. More detailed information on vehicle inspection programs in other countries is provided in Appendix G.2.

4.2. Past Research on the Effectiveness of Inspection Programs

4.2.1. The Role of Vehicle Defects in Crashes

While design and manufacture of vehicle parts (such as brakes, tires, and steering) has improved over the years, the fact is that poor maintenance still causes crashes.

Researchers have conducted a series of studies investigating the contribution of vehicle defects to accidents and crashes. In general, researchers have found that vehicle defects directly contribute to under 10% of all accidents (Crain, 1980; White, 1988; Queensland Travelsafe Committee, 1990; Case at al., 1991; Asander, 1993; Youngman and Stolinski, 1994; Gardner, 1995). However, it is worthwhile to know that the statistics and findings may vary significantly in different countries and studies, depending on the data set and methodologies used. For example, braking, structural, and steering defects are identified as the most common defects in Sweden (Vaughan, 1993b), while tire defects are identified as the most common defects in Australia crash data, followed by braking defects (Case et al., 1991; Vaughan 1993a). This may be due to the fact that accidents may be caused by more than one factor, and it may be difficult to determine the true causes of crashes (Gardner, 1995). Table 4.1 summarizes the studies examining the contribution of defects to crashes (Rechnitzer et al., 2000).

Table 4.1. Summary of studies examining the contribution of defects to crashes

Authors	Findings	Implications
Treat (1977)	Of all crashes studied in-depth, 4.5% had defects that definitely played a significant role in causing the crash, and 12.6% had defects that probably played a contributory role in causing the crash.	Vehicle defects can contribute to causing crashes.
McLean et al. (1979)	Of the vehicles and crashes studied, 12 (17.6%) out of 68 crashed motorcycles were found to have defects. One (1.5%) was considered as definitely contributing to the crash. For PVs, 11 (2.8%) out of 386 cars were found to have defects. Three (0.8%) were considered as definitely contributing to the crash.	A small proportion of crashes are caused by vehicle defects.
Grandel (1985)	Vehicle defects may have contributed to 6.4% of PV crashes, and 5% of two-wheeled vehicle crashes.	Vehicle defects can contribute to causing crashes.
Rompe and Seul (1985)	In general, vehicle defects play a significant causal role in 3–24% of crashes—specifically, 1.3% in Japan. In general, vehicle defects play a contributory role in 4–19% (and possibly up to 33%) of crashes.	
RACQ (1990)	In general, vehicle defects have a significant causal role in 5% of crashes.	
Case et al. (1991)	Vehicle defects contribute to 5.8% of crashes. In addition, 0.6–1.8% of these defects may have been detected in an inspection.	
Asander (1993)	Finland: defects were direct causes or increased damage or injury in 23% of crashes Denmark: defect played a major causal role, were a contributing cause, or increased the consequences in 7–9% of crashes	
Vaughan (1993b)	Brake defects have been found to cause accidents.	Vehicle defects can cause crashes.
Gardner (1995)	In general, vehicle defects have a significant causal role in 2–10% crashes.	
Haworth et al. (1997a)	Mechanical faults contributed to 12% of crashes overall. Mechanical faults contributed to 28% of single-vehicle crashes, and 7% of multi-vehicle crashes.	Defects may cause crashes. Mechanical faults may result in more single-vehicle motorcycle crashes than multi-vehicle crashes.
Haworth et al. (1997b)	3% of crashes were caused by mechanical defects. 37% of crashed vehicles were un-roadworthy.	Defects may cause crashes in some cases.
James Fazzalaro (2007)	Vehicle defects are shown as contributing factors in only about 1% of reported accidents in Connecticut.	
Peck et al. (2015)	The Pennsylvania state safety inspection fail rate for light-duty vehicles is 12–18%, well above the often-cited rate of 2%.	
Manitoba Infrastructure (2018)	The Province of Manitoba, Canada, published the 2017 Commercial Vehicle Safety Alliance inspection report, in which the failure rate for the CMV inspection is given as 30.61% in 2017.	

Table 4.1 reveals that between 1.3% and 24% of crashed vehicles had a defect that played a significant causal role in the crash. According to studies that carried out in-depth inspection and crash investigations (McLean, 1979: Treat, 1977), defects play a significant causal role in 2.9% to 4.5% of car crashes. Table 4.1 also indicates that between 3% and 19% of crashed vehicles had a defect that played a contributory role in the crash. Comprehensive studies indicate that vehicle defects are a contributing factor in 6.5% to 12.6% of car crashes. For motorcycle crashes, it would appear that in 5% to 12% of crashes defects play a contributory role. The detailed review of each study is provided in Appendix G.3.1.

4.2.1.1. Under-Reporting of Defects in Crash Data

An important caveat in considering the research on this topic is that defects are often under-reported due to methodological and statistical shortcomings, as identifying and assessing defects in crashed vehicles is difficult. The expertise and level of investigation that officers on the scene can provide are also factors affecting the determination of defects and their contribution to crashes. When attempting to measure the effects of inspection programs on crash rates, researchers have encountered difficulties in isolating the effects of inspection programs from those effects resulting from other major safety-related programs, other changes in vehicle fleets, and differences between jurisdictions. These problems would suggest an under-reporting of the effects of defects on crashes.

During the investigation of an accident, police officers prepare initial crash reports. However, they do not have enough time, equipment, or qualifications to detect any but the most obvious defects. This then further reinforces the view that defects are not the leading contribution factors in accidents. According to the National Highway Traffic Safety Administration (NHTSA) (1989), Vaughan (1993b), and the Government Accountability Office (GAO) (2015), the contribution of vehicle defects in an accident is under-reported, which results in a lack of reliable crash data on the contribution of vehicle defects to crashes (Rechnitzer et al., 2000). Other reasons why defects may be under-reported is that defects that have caused an accident may be un-diagnosable (e.g., a vapor lock in the footbrake), unrecognized (e.g., drowsiness induced by carbon monoxide poisoning), not tested, or simply not reported (White, 1986b; Rechnitzer et al., 2000). Researchers have found that since crashes are very complicated and often caused by more than one factor, it is difficult for the police officers to identify all the causes (Asander, 1993; Vaughan, 1993a; Vaughan, 1993b; Gardner, 1995). Therefore, worn brakes or tires, for example, may not be recognized or reported if driver error or poor road conditions were involved. The study conducted by Vaughan (1993b) showed that although brakes out of adjustment are the most common serious problem found in the inspection of vehicles at inspection stations, they do not often appear in police reports.

The study team also reviewed literature on the effect of vehicle age in crashes. In general, they found that older vehicles are more likely to be involved in a crash. The corresponding discussion is provided in Appendix G.3.2.

4.2.2. Safety Effectiveness of Inspection Programs

Past studies on the safety impact of vehicle inspections have primarily comprised the following four aspects:

- Comparative studies between jurisdictions that do and do not have inspection programs.
- Before-and-after studies of jurisdictions that have introduced inspection programs.
- Studies comparing the crash rates of vehicles that undergo inspection programs with those vehicles that do not, within the same jurisdiction, and
- Analyses of accident rates of inspected vehicles between periodic inspections.

It is difficult to conduct analyses of the safety effects of periodic vehicle inspection programs as safety effects are likely to be small and compounding factors complicate the interpretation of any safety effects inferred. In conducting the literature review, the study team found significant variation in study findings regarding the role of vehicle defects in crash causation and the effectiveness of inspection programs in reducing defects and crashes. In addition, the effect of inspection programs on accident rates as assessed by the studies varied a great deal, ranging from no effect to an accident reduction rate of up to 16%. Table 4.2 summarizes the studies examining the effectiveness of inspection programs.

Table 4.2. Summary of studies examining the effectiveness of inspection programs

Authors	Findings	Implications on Effectiveness of Inspection Programs
Fuchs and Leveson (1967)	Inspection program is negatively related to mortality, but the net effect of inspection is very small and does not generally differ from zero at high levels of statistical significance.	Inspection program was found to have significant negative effect on accident death rates when the inspection variable was the only independent variable. When more regressors were added to the model, the efficacy of inspection program in reducing mortality rates was not statistically significant.
Little (1971)	Some test states experienced an increase (5%) in death rates following the introduction of inspection program, and some experienced a decrease in death rates over the same period of time. There was no statistical difference in crash rates between inspecting and non-inspecting control groups over time. There was no statistically significant difference in the increase in death rates between test states and the nation as a whole.	Unable to prove inspection program is effective. There was no statistical difference in crash rates between inspecting and non-inspecting control groups over time.
Schroer and Peyton (1979)	Inspected cars had 9.1% fewer accidents than uninspected cars for the first year after inspection. Those who returned for inspections at periodic intervals experienced 21% fewer accidents than those who had never had an inspection. There is a 5.3% reduction in accident rate for inspected vehicles compared to their accident rates before inspection. Those that did not return approached the same accident rate as those who had never been inspected.	Inspection program is effective in reducing accidents. The probability of having an accident decreases immediately after an inspection, then increases until the next inspection.
Crain (1980)	No statistically significant differences in fatality rates between states with periodic motor vehicle inspection and states without it. There was a non-significant tendency toward higher fatality rates in states with periodic motor vehicle inspection. States with random inspections experienced the lowest accident rates.	Unable to prove inspection program is effective in reducing fatality rates. There are no statistically significant differences in fatality rates between states with periodic motor vehicle inspection and states without it.
Loeb and Gilad (1984)	Inspection program reduces fatality rates and accident rates, but not injury rates.	Inspection program is found to be effective in reducing fatality rates and accident rates, but not effective in reducing injury rates.
Berg et al. (1984)	The number of cars in police-reported accidents and the number of injury accidents decreases after the introduction of inspection program.	The inspection program is found to be associated with a decrease in accident and injury rates.

Authors	Findings	Implications on Effectiveness of Inspection Programs
Rompe and Seul (1985)	Inspection program could reduce the number of accidents caused by vehicle defects by about 50%. Inspection program might also affect and reduce the crashes by improving the drivers' knowledge and understanding of the need for regular maintenance, safety issues, and the condition of their own cars.	Inspection program is effective in reducing accidents caused by vehicle defects.
White (1986a)	The probability of having an accident is lowest immediately following an inspection, and then increased by 10–15% over the next six months until a peak one week before the next inspection.	The probability of having an accident decreases immediately after an inspection, then increases until the next inspection.
NHTSA (1989)	Overall crash rate was higher in states without inspection program. Vehicles with defects reported as the contributing cause to the accident were 0.25-2.5% higher in states without inspection program. Vehicles are 2.5% more likely to have tire failure in states without inspection program. No difference in fatality rates between states with and without inspection program.	Inspection program is found to be effective in reducing accident rate, but researchers were unable to find that inspection program is effective in reducing fatality rate. Inspection programs are associated with a decrease in the incidence of defects in the vehicle fleet. Factors other than inspection program may affect the accident rates.
Asander (1993)	After the introduction of inspection program to Sweden, there were fewer defects in the vehicle fleet (7–8% cars with serious defects were replaced), and a 16% decrease in accidents with personal injury.	Inspection program is found to be effective in reducing accidents with personal injury. Inspection program is associated with a decrease in the number of defects in the vehicle fleet.
Fosser (1992)	A study in Norway indicates that there was no difference in the crash rate between cars that undergo inspection program and those that do not. It needs to be pointed out that Norway conducts a significant level of random roadside inspections in addition to the periodically required testing.	Unable to prove inspection program is effective in reducing crash rates.
Holdstock et al. (1994)	Regression analysis using 1990–1991 data for 50 states, District of Columbia, and 10 Canadian provinces. Unable to establish a statistically significant effect of vehicle inspection program on fatality rates or injury rates.	Unable to prove inspection program is effective in reducing fatality rates or injury rates.
Merrell et al. (1999)	Fixed-effect regression analysis using 1981–1993 panel data of 50 states. Unable to establish a statistically significant effect of vehicle inspection program on fatalities or injury rates.	Unable to prove inspection program is effective in reducing fatality rates or injury rates.
Poitras and Sutter (2002)	Inspection has no significant impact on old cars or repair industry revenue, which implies that inspection does not improve the mechanical condition of vehicles.	Unable to prove inspection program is effective in old cars or repair industry revenue. The study makes a distinction between policy ineffectiveness and Peltzman-type offsetting behavior as sources of inspection failure.

Authors	Findings	Implications on Effectiveness of Inspection Programs
Sutter and Poitras (2002)	Regression analysis using 1981–1993 panel data of 50 states. Unable to establish a statistically significant effect of vehicle inspection program on fatality rates or injury rates.	Unable to prove inspection program is effective in reducing fatality rates or injury rates.
Christensen and Elvik (2007)	Inspections strongly improved the technical condition of inspected vehicles, but did not have a statistically significant effect on crash rates.	Unable to prove inspection program is effective in reducing crash rates. However, inspection programs strongly improved the technical condition of inspected vehicles.
Vlahos et al. (2009)	States with vehicle safety inspection programs have significantly fewer fatal crashes than states without programs. Pennsylvania can be expected to have between 115 and 169 fewer fatal crashes each year, corresponding to between 127 and 187 fewer fatalities each year, than it would if it did not have a vehicle safety inspection program. The benefits of the program as derived from all three models exceed the user costs of the program.	Inspection program is found to be effective in improving highway safety and saving lives.
Keall and Newstead (2013)	Going from annual to biannual inspections may reduce likelihood of crashes (8%) and the prevalence of vehicle defects (13.5%). The wide confidence interval for the drop in crash rate (0.4–15%) indicated considerable statistical uncertainty.	Inspection program is found to be effective in reducing crash rate and vehicle defects.
GAO (2015)	Pennsylvania state data show that in 2014, about 20% of vehicles in the state failed inspection and then underwent repairs to pass, well above the often-cited 2%. New Jersey and Oklahoma: A before-and-after analysis indicates that crashes involving vehicle component failure were generally between 2 and 3% of all crashes and varied little after the elimination of safety inspection program. Crash rate did not significantly change for either state.	The analysis does not provide sufficient evidence to conclude that inspection programs did not have an effect on crash rates because additional factors—such as implementation or increased enforcement of traffic safety laws—could influence crash rates.
Peck et al. (2015)	The state safety inspection fail rate for light-duty vehicles is 12–18%, well above the often-cited rate of 2%. Vehicles more than three years old or with more than about 30,000 miles can have much higher rates. The importance of vehicle maintenance over a vehicle's lifetime is proven to be evident.	Inspection program is found to be effective in improving highway safety. Vehicle safety inspections should continue to be implemented in order to keep driving conditions safe.

As Table 4.2 indicates, past literature presents significant variation regarding the effectiveness of inspection programs, which is potentially due to the methodological and statistical shortcomings evident in many of the studies. This is noted by reviewers as well as authors of individual papers about their own studies. Another reason for the variation in the results may be due to other factors that affect the various jurisdictions studied, such as differing levels of other traffic safety measures or different driving environments. These may not have been accounted for in the analyses of the various studies.

The detailed review of each study is provided in Appendix G.3.3.

4.3. Chapter Summary

This chapter summarized the study team's comprehensive literature review of current inspection program practices in Texas, other U.S. states, and other major countries. The extensive review of past studies regarding vehicle defects and effectiveness of inspection programs serves as a solid foundation for this project. Following are some findings from the literature review:

- Crashes are often caused by many factors. The most common vehicle defects that contribute to crashes are braking, tire, and steering defects.
- Vehicle defects are under-reported as the contributing factors in many cases.
- An inspection program improves the condition of vehicles on the road.
- An inspection program increases drivers' understanding of the need for regular maintenance, safety issues, and the condition of their own cars.
- The safety benefits of inspection programs are difficult to establish because of the limited amount of information available concerning the role that component failures play in highway crashes.
- In the relevant body of literature, the various studies' conclusions differ significantly depending on the assumptions made, methodologies applied, and the available datasets used.

Chapter 5. Public Outreach

This study employed various public outreach methods to inform the research efforts:

- Stakeholder interviews
- Workshop with stakeholders
- Survey of Texas vehicle owners
- Survey of inspection station operators

5.1. Stakeholder Interviews

The purpose of the both the interviews and the workshop was to provide a forum to discuss the potential safety impacts and costs associated with eliminating the Inspection Program. The interviews and workshop aimed to identify issues critical to conducting this study and accomplish the following main objectives:

- Present a preliminary list of issues considered important in identifying the impacts of eliminating the Inspection Program.
- Identify additional factors and data sources for evaluating the Inspection Program's safety and cost impacts.

Other objectives that guided the framework for the subsequent data collection and analysis process include identification of other state agencies that will be affected if the Inspection Program is eliminated as well as potential changes to employees staffing levels, inspection fee allocation, and state revenue.

5.1.1. Stakeholder Interview Findings

To obtain more insight into the Inspection Program, the CTR team interviewed nine stakeholders who are experienced industry professionals, including inspectors, car dealers, and inspection station owners. Their experiences, which provided valuable context for this study, are summarized in Appendix H.

The general consensus from the stakeholder interviews is that Texas needs and should retain the Inspection Program. Various stakeholders made several informed suggestions with respect to potential program improvements. Following are key takeaways from the stakeholder interviews.

5.1.1.1. Stakeholder-Identified Issues

- *The inspection process has changed over time, meaning certain important inspection items have been removed*. For example, headlight alignment is no longer conducted, but some station operators believe this inspection step is still needed.

- *Station operators view the Two Steps, One Sticker process as much easier to manage compared to the previous program*. However, there are some disadvantages to having one sticker. In the past, a law enforcement officer could remove the inspection sticker from a crashed vehicle to ensure it was re-inspected after repairs. Now, officers cannot remove an inspection sticker to enforce post-crash safety inspections.
- *Vehicle recall data is a critical piece of information to provide to the motorist during an inspection*. Emission-county inspection equipment can provide vehicle recall data on the final inspection report, but safety-only equipment cannot provide vehicle recall data. The Takata "Alpha" airbag recall, the biggest in history, is attempting to remedy defective airbags that have a 50% chance of causing death or serious injury if activated. Yet, only 65% of vehicle owners perform recall repairs in general, even though repairs are free of charge. Studies in other states have shown up to a 400% increase in recall completion rates by printing recall data on inspection reports (see Appendix I for more detail).
- *The $7 safety inspection fee is likely inadequate for the time and resources an inspection station allocates to an inspection.*

5.1.1.2. Additional Factors Identified by Stakeholders

- *The systemically captured percentage at which vehicles fail a safety inspection the first time through does not represent reality.* Inspection station operators recognize that some vehicles are inspected and repaired without documenting the fact that the vehicle failed inspection the first time. This is partially due to high inspection volume rates near the end and the beginning of the month and the fact that documenting the failure–repair–pass process is time-consuming.
- *DPS conducts both routine audits of station operations and audits using 'decoy' drivers and vehicles that have a defect*. Inspectors and/or inspection stations can receive a citation for non-compliance if the inspector does not discover the defect during a routine inspection. This is an additional cost impact to consider in the efficiency evaluation.
- *Emission counties have different inspection equipment compared with safety-only counties*. Emission-county station operators purchase inspection equipment whereas DIR provides the safety-only equipment at no cost.
- *Some inspectors are concerned about battery leakage that could affect the driver or passenger's safety.* Some car manufacturers have moved the battery to the rear of the vehicle underneath the backseat or in the trunk, but within the passenger compartment space. This item is not currently inspected.

5.2. Workshop

The June 2018 workshop had two major components: the morning plenary session and the after-lunch breakout sessions. The morning plenary session featured presentations from the CTR team on the scope and preliminary findings of this study. The afternoon session was the more interactive portion of the study in which breakout groups discussed various facets of the Inspection Program. Appendix I contains the workshop agenda, plenary session summary, a listing of the questions provided to the breakout groups, and a summary of participants' responses to those questions. Note that the workshop presentations are available upon request from CTR.

5.2.1. Workshop Findings

This section comprehensively reviews the feedback provided during the workshop, which helped identify factors to consider when assessing the impact of the Inspection Program practices in Texas. Following are some notable findings from the workshop.

5.2.1.1. Workshop-Identified Issues

- *Incorporating vehicle recall information into the inspection report has a potential economic and safety benefit for Texas.* Adding recall information to safety inspection reports could create an estimated $242 million of potential Texas revenue inflow at present. Furthermore, incorporating recall information into the vehicle inspection report can add additional value to the Inspection Program by further enhancing safety for all road users.
- *Ride-hailing and ride-sharing vehicles can receive even greater benefits from the Inspection Program.* Ride-hailing and ride-sharing vehicles accumulate many more miles per year and deteriorate at a faster rate than the average privately owned vehicles. At present, these vehicles are inspected under the Inspection Program and do not have a separate inspection. Since these vehicles are more prone to faster rates of wear and tear, they likely benefit to a greater extent from the Inspection Program.
- *Some people may perceive that safety inspectors do not take their job seriously; however, inspectors understand that their job results in saving lives.* Some supporters of the elimination of motor vehicle inspections for passenger vehicles believe that safety inspectors do not take their job seriously, rendering the program ineffective. However, according to the Co-Chair of the Texas State Inspection Association, many companies (such as large tire companies, for example) routinely hold well-attended seminars to emphasize the importance of proper inspection of wear-and-tear items. These seminars are very effective in encouraging inspectors to take pride in their work and re-emphasizing the life-and-death stakes involved. Inspectors know that the outcome of their efforts is saving lives on the road.
- *Increasing the scope of the vehicle safety inspection program such that an inspection becomes too complex could result in false failures from over-testing.* As the complexity of the inspection test increases, the probability that a false failure (an item flagged as defective when in fact it is not) also increases. Additionally, adding more items to the safety inspection process would most likely warrant an inspection fee increase. Survey responses to date have shown that the majority of vehicle owners believe the fee is currently "about right," cautioning against increasing the scope too much.

- *Stakeholders unanimously agreed that Texas needs an Inspection Program and will continue to need one for the foreseeable future*. Stakeholders agreed that neither recent vehicle advancements nor advancements in the next 20 years will eliminate the need to check the wear-and-tear items that are checked during a safety inspection.

5.2.1.2. Additional Factors Identified in the Workshop

- *Annual, first-time failure rate is a tough statistic to mine from existing records, but a first-time failure rate obtained from both vehicle owner and station operator survey responses could overcome this difficulty*. Upon requesting a car inspection, customers are sometimes advised to first fix a failing component as a courtesy and a display of customer service. A number of these interactions are never recorded as failed inspections, making the recorded first-time failure rate lower than the true first-time failure rate. Survey responses about experiential first-time failure rates over time obtained from both motor vehicle operators and inspection station owners could provide a statistically significant estimate of the true first-time failure rate.
- *Eliminating the Inspection Program also eliminates the opportunity to implement future enhancements*. Having vehicle safety inspections for PVs provides an opportunity to increase the scope of the safety inspections in the future, enhancing the benefits of the program.
- *Stakeholders unanimously agreed that the risk for fatality crashes will increase if the Inspection Program is eliminated.* Vehicles with defects have a higher risk of being involved in a crash, including fatality crashes. Additionally, the severity of a crash increases as speed limits increase. Ceasing the program increases the likelihood that more vehicles with defects will be present on Texas roads. Given that Texas has some of the highest posted speeds in the nation, this development would further augment the risk for fatality crashes.

5.3. Analysis of Vehicle Owner Survey

The CTR team conducted an anonymous online survey of vehicle owners using various methods described in Appendix J. A total of 5,937 completed surveys were received from 234 of 254 counties in Texas[2]. This section focuses on only 2 of the 15 questions; Appendix J provides extensive analysis of all survey questions and responses.

It should be noted that these responses do not represent the vehicle owners' experiences or opinions based on just one annual safety inspection. The survey was designed to obtain responses about the safety inspections over the period of time that a survey respondent had their vehicle inspected in

[2] The study team's analysis, submitted to TxDPS on August 31, 2018, was based on 5,937 100% completed vehicle owner surveys. However, to obtain additional data the team continued to invite the public to take the survey from September to November, obtaining an additional 3,366 100% completed surveys (bringing the total number collected to 9,303). These were used to further validate the analysis results and models. Note that the study conclusions, models, and analyses results did not change when the new survey responses were incorporated.

Texas. Thus, these responses do not represent a single year, but the combined experience of 5,937 men and women who have had vehicles inspected over a period from 1 to 40 years. Thus, the survey information provides a programmatic assessment of the Inspection Program.

Figure 5.1 shows the survey responses to this question: “Do you think that safety inspections benefit highway safety in Texas?” The survey responses are subdivided for each response category regarding whether the motorist indicated they had never needed parts or repairs (never failed an inspection) during the entire time they have had vehicle inspections in Texas and those who have needed parts or repairs (have failed a safety inspection at least one time).

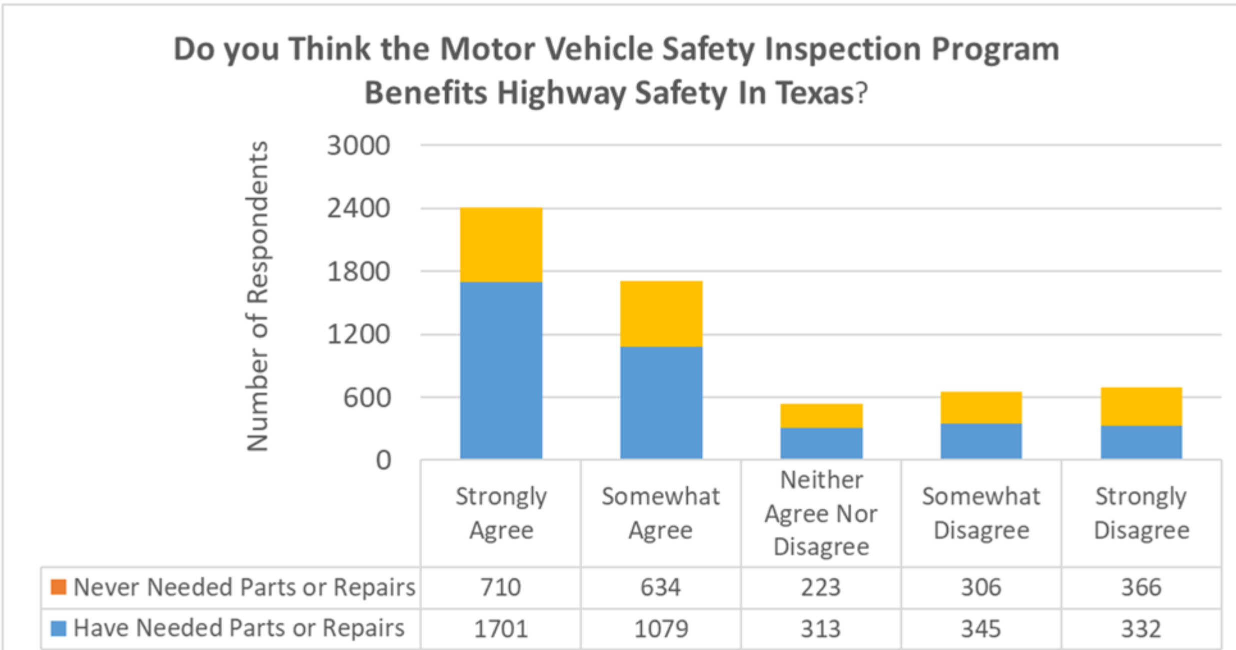


Figure 5.1. Vehicle owner responses: Do you think safety inspections benefit highway safety in Texas?

Approximately 68.3% of survey respondents either ‘Strongly’ or ‘Somewhat Agree’ that safety inspections benefit highway safety, while 22.4% either ‘Strongly’ or ‘Somewhat Disagree’ that safety inspections benefit highway safety. It should be noted that 44% of respondents who ‘Strongly’ or ‘Somewhat Agree’ have never needed parts or repairs, whereas 67% of respondents who ‘Strongly’ or ‘Somewhat Disagree’ have never needed parts or repairs.

Figure 5.2 shows the number of responses to the question of whether vehicle owners think that a safety inspection is a service or not, to which 80% responded that they perceive a safety inspection as a service.

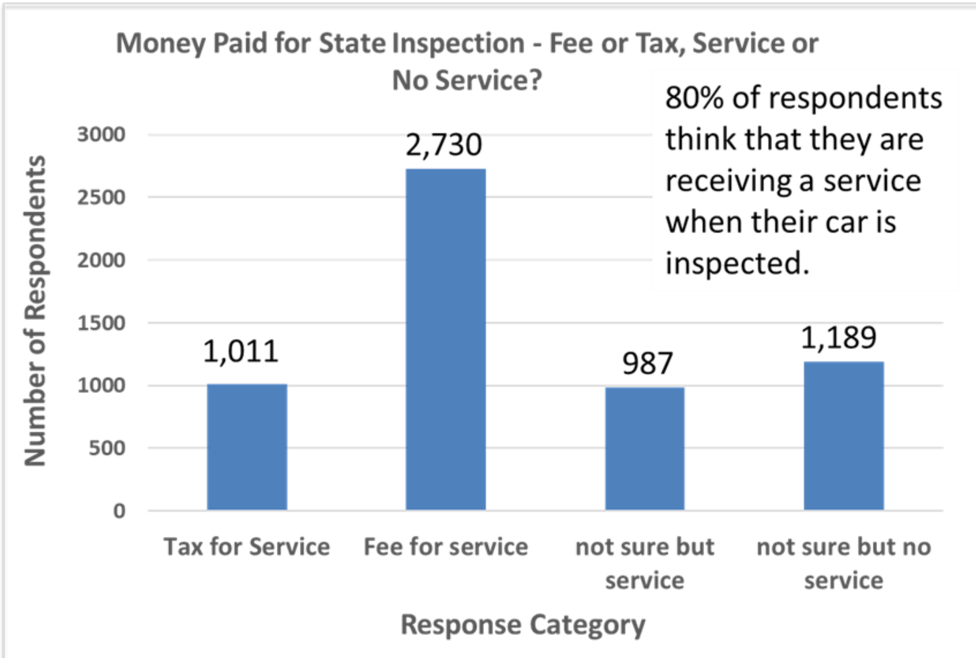


Figure 5.2. Vehicle owner responses: Do you think the safety inspection program provides you with a service or not?

Following are some key conclusions obtained by examining the full set of responses (which are provided in Appendix J).

- Approximately 25% of vehicle owners who reported they had never needed parts or repairs to pass a safety inspection also indicated that the inspection station operator had noticed one or more defects before the inspection started and told them to have the defects repaired, then come back for the inspection. Thus, based on these survey results, first-time failures are under-reported by approximately 25% during the time span represented by this group of survey respondents.
- A majority (68.7%) of survey respondents think that safety inspections benefit highway safety in Texas.
- Approximately 80% of survey respondents think that the Inspection Program provides a service.
- Approximately 88.7% of survey respondents think that vehicle defects such as defective or slick tires, bad brakes, or defective steering mechanisms can contribute to crashes.
- Though some vehicle owners repair maintenance problems as they occur, approximately 45.6% of survey respondents think that they better maintain their vehicle because they know it will eventually need to pass a safety inspection. Some motorists make repairs just prior to the safety inspection while others use the safety inspection as their maintenance program.

5.4. Analysis of Inspection Station Survey

The CTR team conducted an anonymous online survey of inspection station owners through email distribution to over 6,500 stations. A total of 1,582 completed surveys were received from 183 of the 254 Texas counties. Of the 1,582 completed surveys, 757 were from the 17 emissions counties and 805 were from safety-only counties. This section focuses on responses to only two of the survey questions; Appendix K provides extensive analysis of all survey responses.

It should be noted that these responses do not represent the station operator's experience or opinions based on just one year of conducting safety inspections. The survey was designed to obtain responses about safety inspections over the period of time that a survey respondent had performed safety inspections at their station in Texas. Thus, these responses do not represent a single year, but the combined experience of 1,582 station operators who have been performing safety inspections anywhere from 1 to 30 or more years. Thus, the survey information provides a programmatic assessment of the Inspection Program from the inspectors' perspective.

Figure 5.3 shows the survey responses to this question: "How will your business be impacted if safety inspections in Texas are eliminated?"

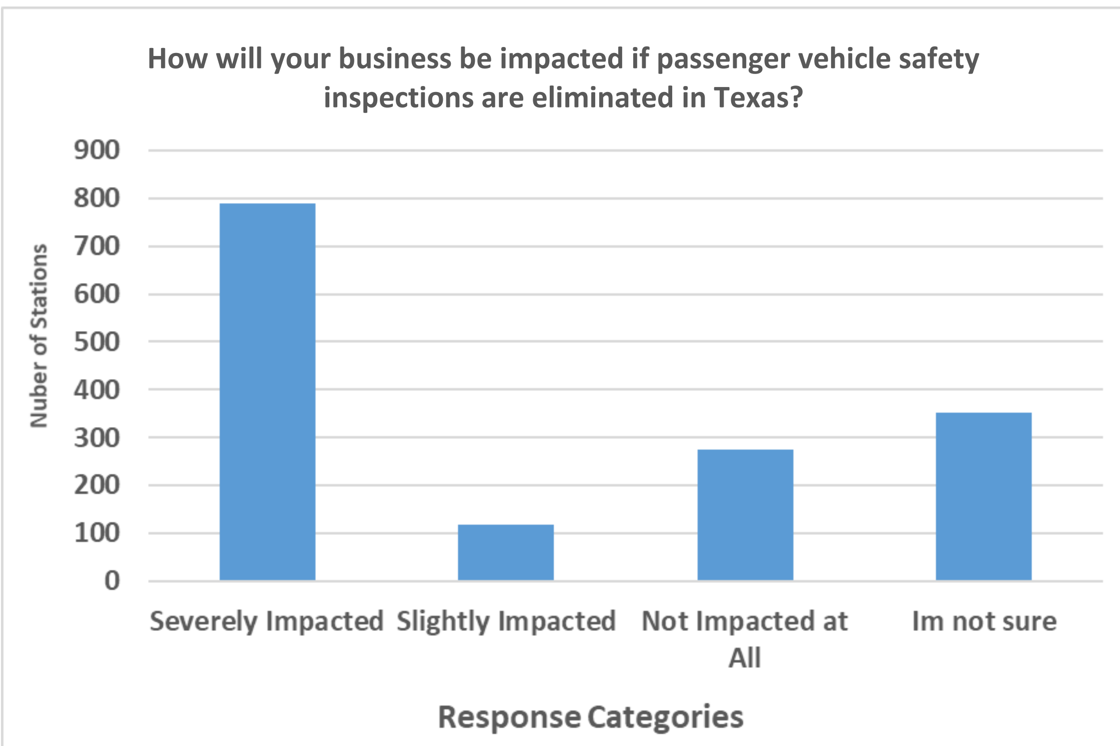


Figure 5.3. Inspector responses: Do you think safety inspections benefit highway safety in Texas?

Approximately 50.5% (790) of station operators surveyed indicated that their business would be severely impacted; 7.8% (119) would be slightly impacted; 17.9% (274) would not be impacted at all; and 22.9% (351) were unsure how their business would be impacted.

Figure 5.4 shows responses to this question: "Do you think the Vehicle Safety Inspection Program improves highway safety in Texas?" Approximately 82.5% of survey respondents indicated 'Definitely' or 'Probably Yes', 7.8% indicated that safety inspections 'Might or Might Not Improve Highway Safety', and 9.6% of stations indicated 'Probably' or 'Definitely Not'.

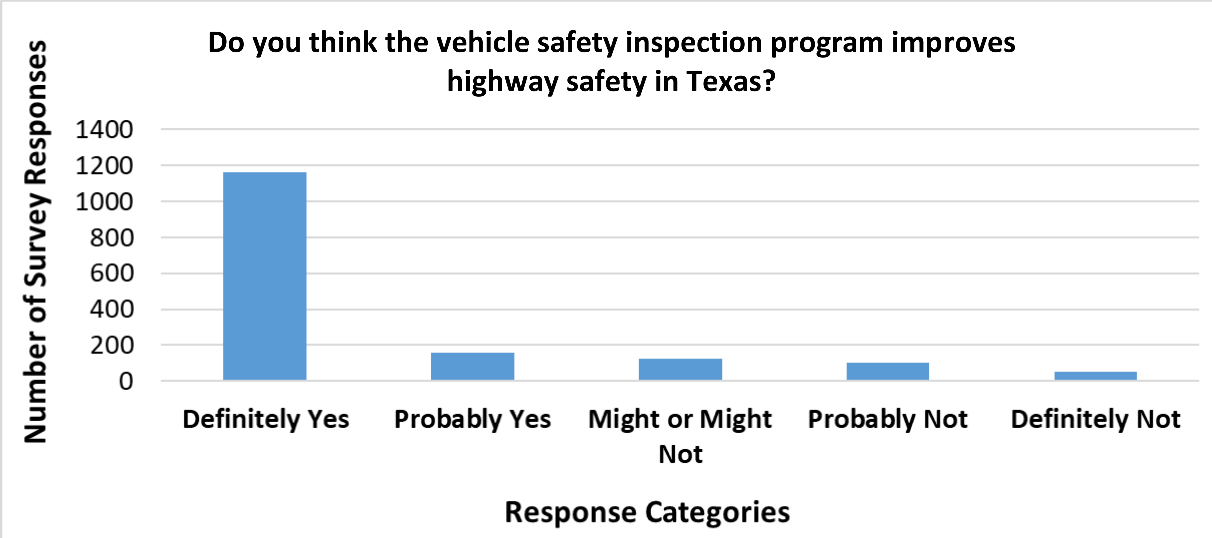


Figure 5.4. Inspector responses: Do vehicle inspections benefit highway safety in Texas?

The majority of inspection station operators think that safety inspections do benefit highway safety. Further, these station operators pointed out that low-income individuals or families may not be able to perform maintenance of their vehicles as needed. In other cases, elderly drivers may not be aware of maintenance issues and appreciate having a safety inspection to ensure that defects are addressed and their vehicles are in compliance.

An extremely important point that should be emphasized is that safety inspections not only benefit the vehicle owner, but also benefit all other drivers on the road. Crashes involving vehicles with defects often occur with another vehicle that does not have defects. In some cases, fatalities or serious injuries resulting from the crash occur in the vehicle without defects. Thus, everyone benefits when all vehicles on the road are in compliance with safety inspection requirements.

Of every 1,000 vehicles inspected, it is estimated that the station operator performs repairs on approximately 265 vehicles (26.5%). The remaining vehicles either pass inspection with no need for repairs or fail inspection and may choose to go elsewhere for parts and repairs, including fixing their vehicle themselves, before the final inspection is performed.

Some station owners who responded that they 'Probably' or 'Definitely [did] Not' think safety inspections support safety took the time to comment that this sentiment reflects their opinions about the state rules and the inspection fee that affects their business operations, rather than directly about how safety inspections affect highway safety.

Following are some key conclusions obtained by examining the full set of responses (which are provided in Appendix K).

- Approximately 25% of the time, inspection station operators noticed one or more defects before the inspection started and told the vehicle owner to have the those items repaired, then come back for the inspection. Thus, again, first-time failures are under-reported by approximately 25% during the time span represented by this group of survey respondents.
- A majority of inspection station operators believe that safety inspections improve highway safety in Texas.
- On average, inspection stations replace parts or perform repairs on about 26.5% of the vehicles they inspect; the rest of the vehicles pass inspection with no need for repairs or are sent elsewhere for repairs due to various reasons.

5.5. Analysis of First-Time Failure Rate

One goal of the CTR team was to develop the annual first-time failure rate, currently not captured in the program. The first-time failure rate includes these categories:

1. vehicles that fail and are repaired at a location other than the inspection station;
2. vehicles that initially fail but are repaired at the inspection station; and
3. vehicles for which, before the inspection, the inspection station personnel told the vehicle owner to fix a component that would fail and then return for an inspection.

Essentially, none of the vehicles in these three categories pass the first time they are presented for inspection. Vehicles that fail under Category 2 are not usually accounted for in the current reporting mechanism; there is no mechanism to capture vehicles that would fail under Category 3.

The CTR team developed two approaches to determine the first-time failure rate using the data from the vehicle owner surveys.

5.5.1. First-Time Failure Rate Method 1

Appendix A.1.5.3 presents a method for determining an annual failure rate, which captures Scenario 1, of 2.63%. Appendix J.2 presents results from the Vehicle Owner Inspection Survey that concluded that 63% of vehicles had failed one or more times over the span of time represented by the survey respondents' inspection histories. Thus, 37% of respondents indicated that they had never been required to obtain a repair or replacement part and therefore their vehicle had never failed an inspection.

The study team developed a methodology to approximate the annual first-time failure rate from these survey responses of a respondent's programmatic failure rate experience. Based on the responses from the vehicle owner survey, the study team approximated the annual first-time failure rate using this calculation:

$$\textit{Annual first time failure rate } (y) = \frac{\textit{Total number of failures from survey}}{\textit{Total number of inspections performed}}$$

$$= \frac{a}{n*v*t}$$

where

a is the total number of failures from survey;
n is the number of total valid responses;
v is the average number of vehicles each respondent owns; and
t is the analysis period, which equals to the average of respondents' experience with the Inspection Program in years.

According to the survey results, there were in total 8,091 first-time failures from 5,998 valid respondents. Therefore, a = 8,091 and n = 5,998. In addition, there were 16,162,382 licensed drivers in Texas in 2016 (FHWA, 2018). Based on the registration data obtained from TxDMV, the total number of registered passenger vehicles (1980 and newer models) in 2016 was 19,640,255. This indicates that the average passenger vehicles per licensed driver in Texas is about 1.2 ($v = 1.2$). The annual first-time failure rate becomes:

$$\textit{Annual first time failure rate } (y) = \frac{8,091}{5,998*1.2*t}$$

Figure 5.5 shows the annual first-time failure rate with different analysis periods.

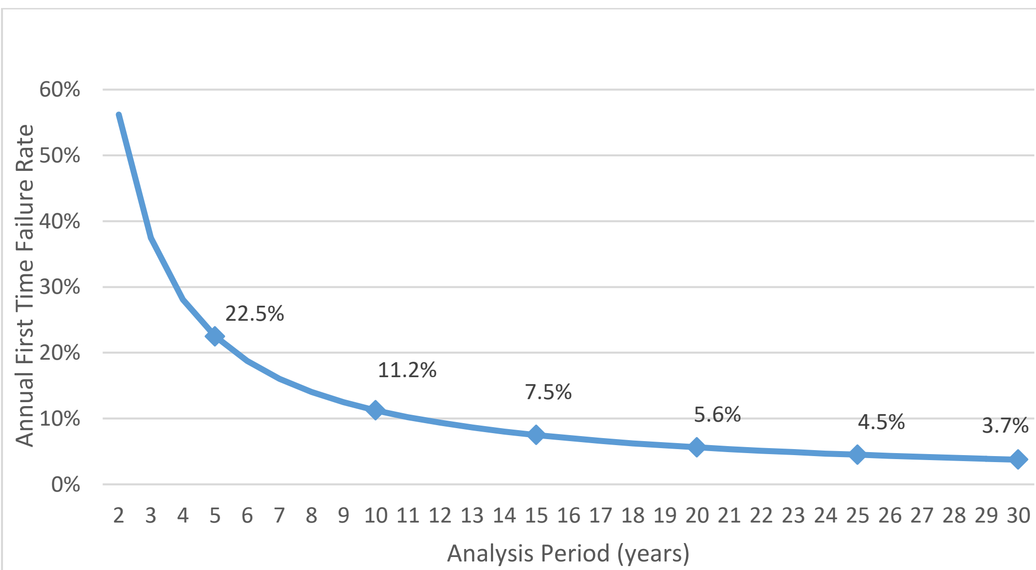


Figure 5.5. Annual first-time failure curve

The annual first-time failure rate and the corresponding analysis period until year 30 is listed in Table 5.1.

Table 5.1. Annual first-time failure rate and corresponding analysis period

Analysis Period	Annual First-time Failure Rate	Analysis Period	Annual First-time Failure Rate
2	56.2%	17	6.6%
3	37.5%	18	6.2%
4	28.1%	19	5.9%
5	22.5%	20	5.6%
6	18.7%	21	5.4%
7	16.1%	22	5.1%
8	14.1%	23	4.9%
9	12.5%	24	4.7%
10	11.2%	25	4.5%
11	10.2%	26	4.3%
12	9.4%	27	4.2%
13	8.6%	28	4.0%
14	8.0%	29	3.9%
15	7.5%	30	3.7%
16	7.0%		

As shown in Figure 5.5 and Table 5.1, as the analysis period increases, the first-time failure rate decreases. This approach results in an approximate first-time failure rate if one picks an analysis period. The unknown remaining factor is determining an analysis period that is reasonable.

According to the registration data obtained from TxDMV, the average model year of a PV in 2017 is 2009. This probably represents a reasonable lower bound on a person's programmatic experience with the system and consequently an upper limit for the first-time failure rate of 12.5%.

Many people will have had multiple vehicles and more years of experience with the Inspection Program, so it is more difficult to develop an upper bound for the analysis period. Most of the data used in developing this analysis approach was contained in an analysis period of less than 15 years, so using 15 years results in a first-time failure rate of 7.5%.

The CTR team determined that more study is needed to establish an upper and lower bound that represents the failure rate based on this data, but 7.5% to 12.5% is a reasonable range. However, one should note that all analysis periods up to 30 years result in an approximate annual failure rate higher than the currently captured 2.63%.

5.5.2. First-Time Failure Rate Method 2

The study team also developed another methodology to determine the annual first-time failure rate based on the survey responses, which focuses more on the individual level. In the survey, vehicle owners were asked to indicate the number of times that they had repairs or purchased replacement parts as a result of a safety inspection (Question 11 in Appendix J). The answers ranged from zero (vehicle never needed any repairs or replacement parts) to as many as 30 times. The study team interpreted the number of times parts were purchased as the number of failures, because those safety issues would cause a vehicle to fail a safety inspection unless remedied.

To obtain the adjusted first-time failure rate, the study team conducted these tasks:

- established the maximum and minimum analysis periods for each individual who had repairs or purchased replacement parts as a result of a safety inspection;
- calculated all probable unadjusted (without considering the average vehicle ownership rate) first-time failure rates for each individual within the minimum and maximum analysis periods;
- summarized and analyzed the statistics of all probable unadjusted first-time failure rates;
- adjusted the first-time failure rates by considering the average vehicle ownership rate.

The maximum analysis period is set as 30 years since the maximum reported number was 30 times. The minimum analysis period is determined when the unadjusted failure rate reaches 100%. Therefore, it varies from individual to individual and equals to the number of times each respondent reported. For example, if the vehicle owner failed three times, the minimum analysis period is three years and the maximum is 30 years. The respondent might fail three times in three years, or they might fail three times in four years, or five years, or 30 years. Following are all probable unadjusted first-time failure rates: $3/3 = 100\%$, $3/4 = 75\%$, $3/5 = 60\%$, … $3/28 = 10.7\%$, $3/29 = 10.3\%$, $3/30 = 10\%$. Similarly, if the vehicle owner failed seven times, then all probable unadjusted first-time failure rates are $7/7 = 100\%$, $7/8 = 87.5\%$, … $7/29 = 24.1\%$, $7/30 = 23.3\%$. In addition, for those who never failed an inspection, all probable unadjusted first time failure rates are: $0/1 = 0\%$, $0/2 = 0\%$, … $0/29 = 0\%$, $0/30 = 0\%$.

The study team calculated all probable unadjusted first-time failure rates for each individual. Consequently, a total of 171,932 probable unadjusted first-time failure rates were obtained. The histogram and cumulative probability of all unadjusted first-time failure rates are presented in Figure 5.6.

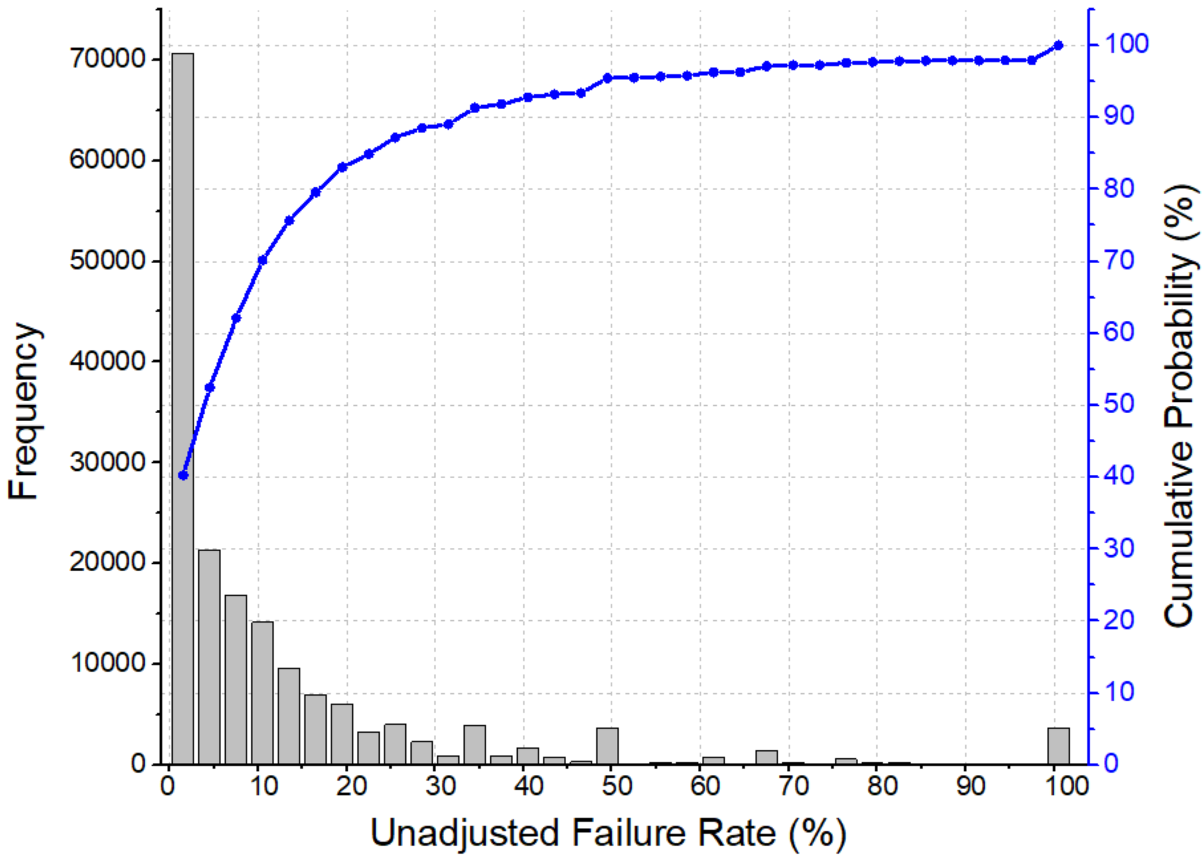


Figure 5.6. Histogram and cumulative probability of unadjusted first-time failure rate

As Figure 5.6 illustrates, the histogram shows an exponential distribution, which is expected because exponential distribution is one of the most common failure distributions in reliability engineering (Ebeling, 2004). Theoretically speaking, failures due to completely random or chance events will follow exponential distribution (Ebeling, 2004). The mean value of all the unadjusted first time failure rates is 12.4%. By considering the average vehicle ownership is 1.2 vehicle per licensed driver, the adjusted mean value of the first time failure rate is $\frac{12.4\%}{1.2} = 10.3\%$, which is in the range of 7.5% to 12.5% from Method 1 and is obviously higher than the currently captured 2.63%. More detailed analyses regarding this methodology can be found in Appendix J.4.

5.5.3. First-Time Failure Rate Summary

If using only the data from the vehicle owner surveys, the true first-time failure rate is unknown. However, by using two methods of statistically analyzing the data available, the CTR team developed estimates of the first-time failure rate that agree closely. Method 1 produced an estimated range of 7.5% to 12.5% and Method 2 produced an estimated average of 10.3%. These values are all in the same range and are higher than the 2.63% captured in the TxDPS database system currently.

Chapter 6. Inspection Databases Examination

This study analyzed three inspection databases to inform the assessment of the Inspection Program:

- The TxDPS inspection database
- An inspection station's records of the City of Houston's inspection program for taxis and limousines
- The Texas Highway Patrol's High Value Dataset

6.1. TxDPS Inspection Database

The CTR team reviewed the TxDPS Inspection Database but was not able to develop additional information for this report.

6.2. Evaluation of Houston Taxi and Limousine Inspection Data

The study team had an unexpected opportunity to analyze a highly specific inspection database, which provided a valuable comparison to the standard Inspection Program data sets. The City of Houston developed its own inspection standards for taxis and limousines that examined about 77 items, including most of the items that are inspected during mandatory state inspection. This inspection was separate from and in addition to the mandatory state Inspection Program. Houston ran this program from 2011 through 2016. As mentioned in Appendix H.2, CTR borrowed the paper copies of Houston taxi and limousine inspection records from an inspection station with whom the City of Houston had contracted to provide taxi and limousine inspections. Since all the taxis and limousines are registered as PVs and they directly serve the traveling passengers, these records are relevant to this study.

The study team analyzed 714 Houston taxi and limousine inspection records. Since the taxis and limousines followed the same Houston inspection standard, the study team combined taxi and limousine inspection results for analysis purposes. Table 6.1 compares the Houston inspection standards (more items are inspected) and statistics with those of the Inspection Program.

Table 6.1 Comparative analyses of Houston taxi and limousine inspection data

	Houston Taxi/Limo Inspection Standards	Inspection Program Standards
First-time failure rate	82.6%	71.6%
Average mileage (miles)	257,640	
Average vehicle age when inspected (years)	6	
For vehicles failed the first inspection, average duration until re-inspection (days)	7	Not Applicable
Average number of defective items per vehicle	4	2
Top six most common defective items (percentages of vehicles)	Brakes (38.5%) Suspension (35.4%) Steering (25.4%) Engine (23.2%) Head lamps (20.2%) Wheel and wheel covers (18.5%)	Brakes (38.5%) Steering (25.4%) Head lamps (20.2%) License plate lamp (16.9%) Stop lamps (14.0%) Tires (13.3%)

As Table 6.1 shows, the first-time failure rate was very high for Houston taxis and limousines under the Houston standards (82.6%), and even under Inspection Program standard (71.6%) where fewer items are inspected. The taxis and limousines have high mileage despite the average vehicle age of only six years. The average number of defective items per vehicle is four under the Houston inspection standard, while the average number of defective items per vehicle is two under Inspection Program standard. Brakes, steering, and head lamps are found to be the top-three most common defective items under the Inspection Program standard.

The high rate of first-time failure for these high-mileage vehicles signifies the importance of ensuring that PVs used for commercial purposes (including PVs used by the increasingly prevalent transportation network companies such as Uber and Lyft) are subject to inspection. More detailed analyses of this data can be found in Appendix L.

6.3. Evaluation of the Texas Highway Patrol High Value Dataset Database

An evaluation of the Texas Highway Patrol High Value Dataset Database for 2013 to 2016 described in Appendix B showed the following:

- 84% of roadside traffic stops by law enforcement for vehicle defects result in warnings, with the remaining 16% as citations.
- About 45% of citations issued by law enforcement for vehicle defects are adjudicated as citations by the courts; the remaining 55% are adjudicated as warnings.
- 56% of vehicle defect warnings and citations are issued during hours of darkness; thus, the majority of warnings are associated with defective lighting.

It would be difficult or impossible to effectively examine tire conditions during hours of darkness. In addition, defective lighting can be observed while a vehicle is in motion, whereas defective or slick tires cannot. Thus, few warnings or citations are issued for defective or slick tires either during hours of daylight or darkness.

The study team was not able to determine if a process is in place to ensure that vehicle defects identified by law enforcement officers during roadside stops are repaired by the vehicle owner.

Chapter 7. Conclusions and Recommendations

7.1. Conclusions

The CTR study team conducted a thorough investigation of the costs and safety impacts of eliminating the Inspection Program. The team reached the following conclusions based on a thorough analysis of safety impacts, analysis of relevant data sets, examination of the Inspection Program's costs and revenues, and a multi-faceted public outreach component.

7.1.1. Safety

- The average crash costs related to vehicles with defects are more than $2 billion per year Most defects are vehicle elements that would have failed a program inspection.
- The frequency of fatalities, incapacitating injuries, and non-incapacitating injuries is higher for crashes involving vehicles with defects. The ratio of fatalities per number of vehicles in crashes is about three times higher for vehicles with defects than that of vehicles without defects, as shown in the following table:

PV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Fatalities per number of vehicles in crashes	1 fatality / 98 vehicles	1 fatality / 346 vehicles	1 fatality / 102 vehicles	1 fatality / 341 vehicles	1 fatality / 114 vehicles	1 fatality / 343 vehicles

- Crashes involving vehicles with defects are twice as likely to result in a fatality than crashes with vehicles that do not have defects.
- The most prevalent type of defect related to fatal crashes is slick or defective tires. Interestingly, 23.5% of survey respondents identified slick or defective tires as a vehicle element they had been asked to remedy during the course of their vehicle inspection history—meaning that the fatality crash rate would likely be higher without such inspections.
- When vehicles from other states are involved in crashes in Texas, the percentage of vehicles with defects is found to be lower for those states that have vehicle safety inspection requirements than states that do not. This indicates that the inspection programs in general may help reduce the number of defective vehicles on the nation's roads.
- The percentage of crashes involving defective vehicles increases with higher speed limits—as does the severity of those crashes. Given that Texas has the highest speed limit in the nation and many high-speed roadways, it is important to consider the potential safety impact of eliminating the safety inspection program in Texas on highway safety, especially on roadways with high speed limit.

- Ensuring that the vehicle owner remedies the defects found by law enforcement officers during roadside traffic stops can enhance highway safety.
- Vehicles with defects that were involved in crashes are three years older than the average registered vehicle, which is nine years old. In other words, the percentage of vehicles with one or more defects that had crashes is higher for older vehicles. This highlights the importance of the Inspection Program to make sure the key components (e.g., tires, brakes, etc.) of old vehicles are in good condition.

7.1.2. Inspection Program Costs and Revenue

- The cost to the State of Texas for operating the Inspection Program is approximately $32 million per year.
- The State of Texas receives revenues of approximately $150 million per year in safety inspection fees paid at annual vehicle registration, inspection station and inspection technician licensing and certifications, and other fees.
- The 12,000 station owners, employing 45,000 inspectors, share net revenue of $131 million per year from the $7 per vehicle inspection fee.
- Eliminating the Inspection Program would result in a loss of revenue to the Clean Air Fund of approximately $39 million per year and a loss of revenue to the Texas Mobility Fund of approximately $83 million per year.
- The cost to motorists for inspection fees and time is estimated to be approximately $307 million per year. This is approximately $16 per vehicle per year for each of the 19 million vehicles owners, in terms of fees and time spent.

7.1.3. Public Perception of the Inspection Program

- In a survey of 5,937 drivers, approximately 80% think that they receive a service when having their vehicle inspected.
- Approximately 89% of survey respondents think that vehicle defects that are corrected through the Inspection Program either ‘definitely’ or ‘probably’ could contribute to an accident.
- Approximately 68.6% of survey respondents ‘strongly agree’ or ‘somewhat agree’ that the Inspection Program benefits highway safety in Texas.
- Approximately 60.6% of survey respondents think that having their vehicle inspected ‘definitely’ or ‘probably’ benefits highway safety in Texas.
- The survey analysis resulted in the following percentages for the four categories of inspection results that were evaluated. It bears noting that these are programmatic percentages, representing decades of respondent experiences. Individuals in this group may had their vehicle inspected over a span of 1 year to approximately 40 years. Further,

respondents might have failed only 1 time, or might have failed 8, 10, or 15 times, or up to every time they had their car inspected, according to respondent comments. Following are the four inspection result categories and their percentages

  - 37% of vehicle owners reported that their vehicles have never required a replacement part or repair and thus have always passed inspection the first time.
  - 15.7% of vehicle owners reported that their vehicle has never needed a repair or replacement part—however, the station operator observed a defect prior to beginning the inspection and told the owner to have it repaired and then return for an inspection. Thus, this group is counted among those who have had first-time inspection failures.
  - 26.5% of vehicle owners reported that the inspection station failed their vehicle, but was able to perform the repairs so that the vehicle could pass inspection.
  - 20.8% of vehicle owners reported that the inspection station failed their vehicle, but they went elsewhere for repairs (out of either choice or necessity), then returned to the station for a second inspection before passing.

This results in 37% of vehicle owners having never failed an inspection and 63% of vehicle owners having failed an inspection at least once over the programmatic time span.

- When using only the data from the vehicle owner surveys, the true first-time failure rate is unknown. However, by using two methods of statistically analyzing the data available, the CTR team developed estimates of the first-time failure rate that agree closely. Method 1 produced an estimated range of 7.5% to 12.5% and Method 2 produced an estimated average of 10.3%. These values are all in the same range and are higher than the 2.63% captured in the TxDPS database system currently.
- Retaining the Inspection Program allows an opportunity to improve future inspection processes. Stakeholders identified the following potential improvements to the Inspection Program:
  - Incorporate information about vehicle recalls in the inspection report. This is currently done in the 17 emissions counties, but not in the 237 safety-only counties. States that have incorporated notice of vehicle recalls, including the Takata Airbag, in the safety inspection reports have seen an increase in the number of serviced recalls. Texas has approximately 1,000,000 vehicles still on the road with Takata Airbags and is at a higher risk of airbag explosions due to high heat and humidity.
  - Tire age should be considered in addition to tread depth as an inspection factor. The National Transportation Safety Board and tire manufacturers have indicated that tires deteriorate with age and can contribute to severe crashes.
  - Retaining the Inspection Program will support future enhancements that allow new inspection procedures, yet to be determined, for autonomous and connected

vehicles. In any case, these vehicles will have physical components that wear out, just as current and older vehicles do.

- Eliminating the Inspection Program will also mean that high-mileage taxis, limos, and personal vehicles used for ride-sharing services are no longer inspected.

7.2. Recommendations

The results of the analyses conducted in this report indicate that the Inspection Program saves lives and enhances vehicle safety. The CTR study team strongly recommends the following:

- Retain the Inspection Program for PVs.
- Conduct a further study to consider whether potential additional inspection items, such as tire age and recall information, should be included in the Inspection Program to further enhance highway safety in Texas.

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Appendix A. Economic Impact Analysis

The economic analysis of the Inspection Program comprises the following four general areas:

- **Basis, Information, Estimates, and Assumptions**

  This area contains general information about the program, the sources of that information, and the specific information needed to make the necessary calculations.

- **Income and Expenses for the Inspection Program (Continuing the Program)**

  This area identifies the revenue and expenses for the station owners and inspectors, the State of Texas, and vehicle owners. This is a snapshot of the current condition with the Inspection Program in place.

- **Income and Expenses for the Inspection Program (Discontinuing the Program)**

  This area identifies the revenue and expenses for the station owners and inspectors, the State of Texas, and vehicle owners. This assumes that the Inspection Program is discontinued by the Legislature.

- **Summary and Additional Considerations**

  This area provides a summary of the preceding revenue and expenses identified for each party and additional points and considerations that may result from discontinuing the Inspection Program.

A.1. Basis, Information, Estimates, and Assumptions

First and foremost, the basis of this study is the safety-only Inspection Program for passenger vehicles (PVs). This study does not address safety inspections for commercial motor vehicles (CMVs); nor does it address emissions testing for any vehicle.

To determine the revenues and expenses of various parties to the Inspection Program, the CTR study team gathered pertinent information and made certain estimates and assumptions necessary to most accurately determine those income and expense figures.

As much as possible, the CTR study team used the most current data available. This usually means data from FY 2017. This data changes from year to year and is driven by new vehicle sales and retirement of vehicles.

Information and data sources include the following:

- Texas Transportation Code
- Texas Administrative Code
- Literature reviews

- Texas Department of Public Safety (TxDPS)
- Texas Department of Motor Vehicles (TxDMV)
- Texas Department of Information Resources (TxDIR)
- Texas Commission on Environmental Quality (TCEQ)
- Texas Comptroller of Public Accounts (TxCPA is a pass-through for all monies remitted to the state)
- TxDPS Vehicle Inspection Advisory Committee
- Stakeholder workshop

A.1.1. Program Governance

The Inspection Program is governed by:

- Texas Transportation Code, Title 7, Subtitle C, Chapter 548, Subchapter A and
- Texas Administrative Code Title 37, Part 1, Chapter 23, Subchapter C

These set the program framework, administration, rules, fee structure, and fee disposition.

A.1.2. Fees Collected at Registration

Vehicles more than 2 years old require an annual safety inspection. Vehicle owners are charged either a $7.50 or a $5.75 fee to the state remitted at time of registration for safety inspection (TxDPS, 2016). The fee consists of these components:

- $2.00 for the Clean Air Fund,
- $3.50 for the Texas Mobility Fund, and
- $2.00 or $0.25 for Texas.gov fees to support website and database functions (vehicles in safety-only counties incur the $2 charge, while vehicles in emissions counties incur a $0.25 charge).

New vehicles (new and never registered) require a safety inspection good for 2 years. Vehicle owners are charged a state fee of $16.75 or $15 remitted at registration. The fee consists of these components:

- $2.00 for the Clean Air Fund,
- $12.75 for the Texas Mobility Fund, and
- $2.00 or $0.25 for Texas.gov fees to support website and database functions (vehicles in safety-only counties incur the $2 charge, while vehicles in emissions counties incur a $0.25 charge).

A.1.3. Fees Paid at Inspection

Vehicle owners are charged a fee of $7.00, paid to the station owner, for all safety inspections (one-year or two-year). The Transportation Code allows no more than $7.00 paid to station owners. Station owners are free to charge less. For our purposes, the CTR study team will use a standard fee of $7.00 per inspection.

A.1.4. Station Certification and Inspector License Fees

Station owners pay a certification fee of $100 plus $2 to support Texas.gov every other year. This is equivalent to $51 per year. The $100 portion of the fee goes to the Texas Mobility Fund.

Inspectors pay a license fee of $25 plus $2 to support Texas.gov every other year. This is equivalent to $13.50 per year. The $25 portion of the fee goes to the Texas Mobility Fund.

A.1.5. Inspection and Registration Data and Calculations

The CTR study team acquired relevant inspection, registration, and support data from TxDPS, TxDMV, and TxDIR and used this data to determine the number of vehicles inspected/registered, numbers of safety-only and emission/safety inspections, and apparent inspection failure rates. Tables A.1 and A.2 contain a substantial amount of data for use in our calculations. Table A.1 shows TxDPS inspection data and other data for stations and inspectors. Table A.2 shows TxDMV data based on registered vehicles.

A.1.5.1. Number of Vehicles Registered/Inspected

TxDPS inspection data is based on the number of inspections performed and is broken out to show the number of two-year inspections, safety-only inspections for motorcycles/trailers, and safety-only inspections and safety plus emissions testing. Inspections in emissions counties have no breakout for commercial and non-commercial vehicles, complicating the analysis.

TxDMV data shows a breakout of PVs, light trucks, and motorcycles (no trailers).

The TxDPS and TxDMV numbers do not agree because these two sets of numbers account for different aspects the program: vehicle inspections versus registrations. One would think that the number of vehicles registered should equal the number of inspections, but there are complications. New PVs and light trucks get a two-year inspection when first registered. These are counted in the year performed, but are not part of the inspection count for the next year as these vehicles are in the second year of the initial two-year inspection cycle. Some vehicles are sold out of state. Some vehicles are destroyed in accidents. Some vehicles get more than one inspection in a year.

Although the basis of the numbers is different, the CTR study team chose to combine the TxDPS and TxDMV data to develop the breakout number calculations necessary to perform the economic evaluation. We believe the error this introduces is not significant and represents a “best estimate” of these numbers. These numbers also change every year based on new vehicles sold, vehicles out of service, and vehicle location (safety-only versus emission/safety counties).

Table A.1. TxDPS Inspection Program data (based on TxDPS FY17 inspection statistics)

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
Total Emissions Inspections													
El Paso - TSI/OBD	44,035	42,632	39,675	40,860	48,739	50,843	63,232	49,674	50,750	46,834	46,666	47,881	571,821
Required Emissions Only	641	547	470	394	540	549	751	636	605	582	622	649	6,986
DFW/HGB - ASM/TSI	12,971	12,536	10,713	10,361	10,078	11,078	12,889	10,423	10,959	8,912	8,951	8,243	128,114
DFW/HGB - OBD	693,941	683,595	630,152	677,323	731,579	742,068	878,232	757,054	837,806	786,685	803,204	734,579	8,956,218
Austin - TSI/OBD	94,889	91,649	84,858	91,088	99,111	93,743	107,099	100,154	113,547	107,826	106,924	105,993	1,196,881
Total	846,477	830,959	765,868	820,026	890,047	898,281	1,062,203	917,941	1,013,667	950,839	966,367	897,345	10,860,020
Total Safety-Only Inspections													
Trailer/Motorcycle	75,747	70,372	52,916	44,554	60,808	73,518	97,455	90,900	98,626	91,656	81,756	76,304	914,612
Safety 1-Year	755,309	727,129	678,133	716,144	779,461	793,638	953,373	776,261	844,207	823,971	806,212	801,111	9,454,949
Commercial/Trailer	23,745	22,715	20,891	19,742	26,912	27,248	37,332	27,153	26,866	25,573	22,933	25,723	306,833
Safety-only 2-Year	139,300	142,668	132,010	138,693	129,454	122,119	152,485	132,205	137,678	130,817	111,010	120,334	1,588,773
Commercial/ Windshield	31,126	30,806	27,906	27,387	38,215	40,929	65,937	40,368	36,498	36,124	32,968	34,605	442,869
Total	1,025,227	993,690	911,856	946,520	1,034,850	1,057,452	1,306,582	1,066,887	1,143,875	1,108,141	1,054,879	1,058,077	12,708,036
Total Inspections	1,871,704	1,824,649	1,677,724	1,766,546	1,924,897	1,955,733	2,368,785	1,984,828	2,157,542	2,058,980	2,021,246	1,955,422	23,568,056
Total # of Passing VIRs Issued													
El Paso - TSI/OBD	41,926	40,441	37,714	38,818	46,133	47,973	59,749	47,148	48,054	44,350	44,040	45,099	541,445
Trailer/Motorcycle	75,491	70,132	52,734	44,415	60,562	73,276	97,112	90,571	98,323	27,984	81,473	76,051	848,124
Safety-only (1-Year)	743,768	715,912	668,164	705,955	763,652	775,907	932,997	760,593	827,962	807,795	790,601	785,450	9,278,756
Required Emissions Only	581	496	404	356	488	489	694	579	550	535	566	601	6,339
Commercial/Trailer	23,291	22,283	20,487	19,353	26,363	26,686	36,559	26,588	26,399	25,107	22,502	25,238	300,856
DFW/HGB - ASM/TSI	10,990	10,593	8,951	8,725	8,484	9,163	10,719	8,739	9,184	7,525	7,517	6,908	107,498
Safety-only (2-Year)	139,294	142,664	132,010	138,688	129,449	122,116	152,481	132,198	137,673	130,813	111,008	120,333	1,588,727
DFW/HGB - OBD	654,504	644,000	594,939	639,721	688,095	697,961	826,489	714,679	792,763	744,215	759,468	694,133	8,450,967
Commercial/ Windshield	30,085	29,797	27,027	26,598	36,950	39,556	63,674	38,964	35,396	34,995	32,017	33,522	428,581
Austin - TSI/OBD	87,491	84,407	78,550	84,152	90,438	85,516	97,811	91,870	104,477	99,169	98,006	97,270	1,099,157
Total	1,807,421	1,760,725	1,620,980	1,706,781	1,850,614	1,878,643	2,278,285	1,911,929	2,080,781	1,922,488	1,947,198	1,884,605	22,650,450
Total Safety-Only Failures	23,763	23,495	20,629	21,188	31,897	34,355	40,102	31,780	33,134	32,117	32,015	30,896	355,371
# of Active Stations	11,715	11,742	11,772	11,798	11,817	11,835	11,878	11,909	11,956	11,979	11,988	11,957	

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
# of Emissions Stations	5,237	5,251	5,265	5,272	5,283	5,283	5,318	5,349	5,364	5,384	5,401	5,413	
# of Active Inspectors	35,005	35,975	36,815	37,523	38,281	39,100	40,019	40,760	41,599	42,362	42,982	43,754	
# of Station Licenses Issued													
Initial Licenses Issued	91	94	82	113	98	115	145	104	138	105	94	118	1,297
Renewal Licenses Issued	0	1	0	0	302	175	285	322	258	752	2,817	5,425	10,337
Total Licenses Issued	91	95	82	113	400	290	430	426	396	857	2,911	5,543	11,634
# of Suspend/Revoke													
Station Suspend/Revoke	1	5	2	2	1	5	1	4	2	7	8	5	43
Inspect. Suspend/Revoke	45	49	43	66	35	35	31	44	31	46	44	65	534
Total Suspend/Revoke	46	54	45	68	36	40	32	48	33	53	52	70	577
# of Enforcement Actions													
Station Re-education	45	32	31	19	34	37	27	32	45	46	31	27	406
Station Warning	13	17	10	6	6	10	10	10	15	16	10	7	130
Station Citation	17	24	18	8	8	12	11	14	7	6	7	12	144
Station Suspension	0	0	0	0	0	0	0	0	0	0	0	0	0
Stations Revocation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Station	**75**	**73**	**59**	**33**	**48**	**59**	**48**	**56**	**67**	**68**	**48**	**46**	**680**
Inspector Re-education	50	51	46	21	42	53	43	34	81	81	52	43	597
Inspector Warning	13	20	10	7	5	9	10	10	12	16	18	8	138
Inspector Citation	127	165	103	73	84	139	110	99	86	81	93	83	1,243
Inspector Suspension	0	0	0	0	0	0	0	0	0	0	0	0	0
Inspector Revocation	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inspector	**190**	**236**	**159**	**101**	**131**	**201**	**163**	**143**	**179**	**178**	**163**	**134**	**1,978**
Total Enforcement	**265**	**309**	**218**	**134**	**179**	**260**	**211**	**199**	**246**	**246**	**211**	**180**	**2,658**
New Inspector License Issued	926	970	877	743	791	846	942	778	858	806	662	832	10,031

TSI = Two Speed Idle
OBD = On-Board Diagnostics
ASM = Acceleration Simulation Mode

DFW = Dallas-Fort Worth Area emissions counties
HGB = Houston-Galveston-Beaumont Area emissions counties

Table A.2. TxDMV registration data for PVs, light trucks, and motorcycles

Fiscal Year	Total PVs <=6,000 Lbs.	Total Trucks - One Ton or Less (Pickups)	Total Motorcycles	Total All Vehicles Registered
2001	9,984,030	4,813,943	201,834	17,906,116
2002	10,187,592	5,044,364	228,626	18,707,486
2003	10,174,751	5,139,701	250,589	18,621,915
2004	10,296,782	5,269,577	278,376	18,949,499
2005	10,517,928	5,371,040	313,619	19,144,792
2006	10,726,666	5,434,231	344,846	20,059,065
2007	11,069,564	5,592,441	372,862	20,864,318
2008	11,239,751	5,540,227	423,351	21,185,173
2009	11,453,354	5,588,568	423,444	21,446,721
2010	11,620,482	5,609,210	419,722	21,570,282
2011	11,832,416	5,612,457	430,422	21,939,786
2012	12,378,139	5,777,174	439,029	22,618,153
2013	12,818,065	5,854,158	438,960	23,227,032
2014	13,267,039	5,918,921	437,949	23,886,263
2015	13,288,425	5,780,988	375,455	23,751,503
2016	13,979,501	5,990,813	380,793	24,053,612
2017	14,299,326	6,055,188	375,169	24,527,939

The CTR study team used the following approach to determine the numbers of vehicles to use for fee calculations.

Since fees to the state are collected at registration, we need to know the number of non-commercial vehicles that get one-year and two-year inspections.

One can use TxDMV data for the numbers of cars, light trucks, and motorcycles. One can use TxDPS data to determine the number of trailers, 2017 two-year inspections, and 2016 two-year inspections. The 2016 two-year inspections incurred fees in 2016, but are not subject to fees in 2017.

- Cars (C) = 14,299,326
- Light Trucks (LT) = 6,055,188
- Motorcycles (M) = 375,169
- Trailers (T) = TxDPS motorcycles/trailers – TxDMV motorcycles = 539,443
- TxDPS 2017 Two-Year = 1,588,773
- TxDPS 2016 Two-year = 1,658,184
- **Number of vehicles with fee at registration of $7.50 or $5.75 = C + L + M + T - TxDPS 2017 Two-Year - TxDPS 2016 Two-year = 18,022,169**

- **Number of vehicles with fee at registration of $16.75 or $15.00 = TxDPS 2017 Two-Year = 1,588,773**

This is total of 19,610,942 non-commercial vehicles registered and we will use this as the total number of Inspection Program inspections.

A.1.5.2. Number of Safety-Only Inspections and Safety plus Emissions Inspections

Starting with the total Inspection Program inspections of 19,610,942, TxDPS data shows the number of safety-only Inspection Program inspections is 11,958,334, which we subtract from the total number of inspections to arrive at 7,652,608 non-commercial vehicles that were inspected for both safety and emissions. This is 39% of all current non-commercial vehicles currently subject to the Inspection Program.

A.1.5.3. Apparent Inspection Failure Rates (Safety-Only Inspections)

Table A.1 shows a breakout for failed safety-only inspections, which includes all vehicles (both commercial and non-commercial), from which the CTR study team developed a failure rate. For these safety-only inspections, there were 12,708,036 inspection and 335,371 failures for a 2.63% failure rate. This refers to vehicles that failed safety-only inspection and left without remedying the source of the failure, not to vehicles repaired during inspection. There is not a breakout for failed safety/emissions inspections.

A.1.5.4. Stations, Inspectors, and Locations

Table A.1 shows TxDPS data on the number of certified stations and inspectors. The number fluctuates, so the CTR study team will use the numbers for August 2017 that show 11,957 certified stations and 43,754 certified inspectors.

TxDPS shows data on the number of stations in emissions counties (conducting both emissions and safety inspections) and in safety-only counties (conducting only safety inspections). Following is the breakdown of these two station types:

- 17 emissions counties with 5413 stations
- 237 safety-only counties with 6544 stations

A.1.5.5. Data Collection and Database

In safety-only counties, the program supplies a safety inspection aid and electronic database connection device known as a VIC (Vehicle Inspection Connection) unit. TxDIR supplies these electronic devices through a third-party contractor. TxDIR has a new contract for these services. The contract is to supply any needed hardware for new stations, replace non-functioning hardware for existing stations, and provide a call center for stations to troubleshoot VIC units and internet connectivity. The contract is based on 6535 VIC units in service at any time, at a rate of $29.38 per VIC unit per month, amounting to a contract value of $2,303,980 per year. This may be adjusted if the number of TxDIR-supported VIC units is significantly higher.

A portion of the Texas.gov fee charged to vehicle owners at registration funds this service.

A.1.5.6. Other Loss of Income and Additional Expenses from Discontinuing the Inspection Program

TxDPS and TCEQ provided information on loss of income to certain accounts and costs associated with discontinuing the program.

- TxDPS identified a one-time cost of $33,480.
- TCEQ reports that the Clean Air Fund currently derives approximately one-third of its funding from the $2 per vehicle safety fee. Using 2017 inspections, this is 19,610,942 vehicles per year × $2 per vehicle = $39,221,884 per year.
- TCEQ would also incur an $800,000 one-time cost for programming changes to all the emission/safety testing-reporting devices used in emissions counties. This is to remove the Inspection Program reporting from the emissions-testing system.
- Since the emissions inspection program is separate from the Inspection Program, one can assume that TxDPS would still be the agency administering the emissions program, meaning TxDPS would continue to incur that program's administrative costs.

A.1.5.7. Additional Area-Specific Assumptions

The CTR study team will make some additional assumptions in other areas, as specified in the following sections.

A.2. Income and Expenses for the Inspection Program (Continuing the Inspection Program)

This section identifies the revenue and expenses for the station owners and inspectors, the State of Texas, and vehicle owners. This is a snapshot of the current condition with the Inspection Program in place and would continue to represent revenue and expenses for parties going forward if the program is not discontinued.

A.2.1. Station Owners and Inspectors (Continue Inspection Program)

Figure A.1 shows a graphical depiction of the revenue and expenses for the vehicle station owners and inspectors discussed in this section.

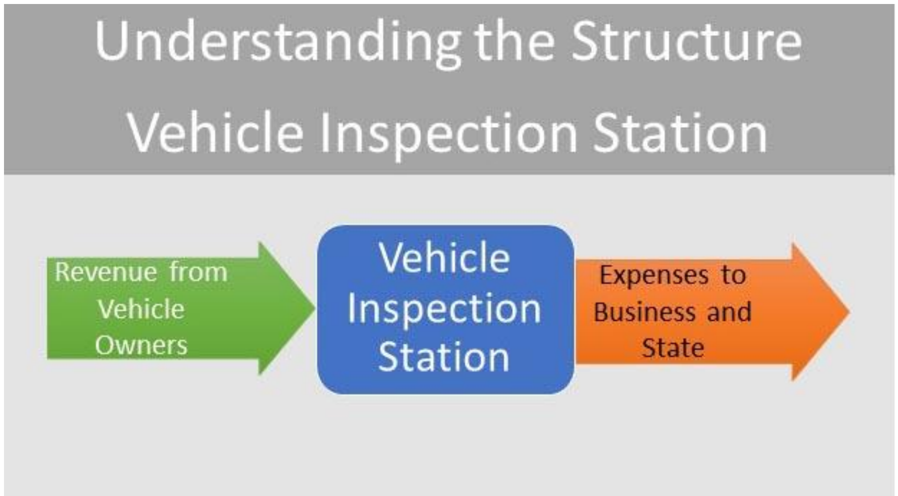


Figure A.1. Economic analysis—station owners and inspectors

A.2.1.1. Revenue

The CTR study team identified one source of revenue for station owners, which is the inspection fees remitted to the station owner by the vehicle owner at the time of inspection, calculated as:

19,610,942 inspections per year × $7.00 per inspection = $137,276,594 per year

It should be noted that a station may have other revenue derived from the program if:

- Maintenance is required for a vehicle to pass an inspection,
- The station is able to perform that work, and
- The vehicle owner agrees to have the work performed at that station.

This revenue would be unknown and outside the scope of this study.

Since there are no more identified revenue sources, the total revenue is $137,276,594 per year for station owners.

A.2.1.2. Expenses

A station owner incurs several areas of expense that offset the revenue. We list those here along with estimated costs; the testing and database communication device cost is listed last, as an extended narrative follows that item. Tables A.3 and A.4 then summarize the average costs for both establishing and maintaining an inspection operation.

1) *Station owners must have a facility that meets requirements of the Texas Administrative Code*. These include being a permanent facility, at least two walls and a roof, a hard-surface floor, adequate lighting, and secure storage of equipment among other requirements. We will not be able to place a value on this cost, but mention it as a cost of doing business.

2) *Printer*. All systems require a printer to provide an inspection report to the vehicle owner. We estimate this as a one-time $200 cost plus another $200 annually to cover the ongoing cost for consumables (paper and toner).

3) *Data transmission service (telephone line or internet access)*. We will assume $20/month ($240 per year).

4) *Station owner certification fees* equivalent to $51 per year (fee of $102 for a two-year term).

5) *Inspector license fees* equivalent to $13.50 per year (fee of $27 for a two-year term).

6) *Liability insurance*. Since safety inspectors drive the vehicle owners' cars to conduct testing, station owners need liability insurance. During a meeting with stakeholders, station owners indicated that if they did other business, such as auto repair, their liability insurance for that business would be sufficient. We are documenting the need for insurance here, but will not include it as an additional expense of the Inspection Program for station owners.

7) *Gas cap tester*. This one-time cost averages $600.

8) *Tire tread gage*. This one-time cost averages $4.

9) *Tint meter*. This one-time cost averages $80.

10) *Testing and database communication device*. This would be $0 for safety-only counties.

    As established earlier, the state is divided into safety-only counties and emissions counties. The 237 safety-only counties require only a vehicle safety inspection, while the 17 emissions counties require both a safety inspection and emissions testing.

    For the 6544 stations in safety-only counties, the state provides the testing equipment—the TxDIR-supplied VIC (see the Data Collection and Database section for a full description).

    In emissions counties, station owners provide their own equipment (at their cost) from an approved list of equipment providers. Emissions testing is additional work and requires more complicated testing equipment. By statute and rule, stations conducting emissions testing receive an additional fee for this testing, which helps offset the equipment purchase and maintenance costs. These units also function to collect the safety inspection information and record all information in a database. The one-time cost for the equipment purchase averages about $8000. Additionally, the equipment must have a maintenance agreement, which averages $800 per year. Emissions counties are in more populated areas of the state and consequently have more vehicles for testing (and thus a greater number of vehicle owners paying the emissions testing fee). While Texas has only 17 emissions counties, those counties contain 5413 of the 11,957 total stations.

    The self-funded nature of the emissions testing is a complicating factor that must be addressed in our analysis. The CTR study team determined two primary methods to address it:

1) divide stations into safety-only and emissions categories and break them out separately for the final expenses, or

2) assign the additional expenses to the emissions-testing program itself—as it is a separate program from the Inspection Program and will not be discontinued since it is federally mandated—and not include these costs as part of the Inspection Program.

The second option makes sense and simplifies the cost calculations. Therefore, the CTR study team decided to establish the costs (in the above narrative), but for simplicity keep them out of the current analysis. Thus, we assign a testing and database communication device cost of $0 for all stations.

From these identified expenses, we can generate a cost for getting into business and ongoing costs for staying in business.

To get into business (assuming they have a facility that meets the station requirements, already have liability insurance, the state provides the data transmission equipment, and they have only one inspector), a station's initial Inspection Program-related costs would be approximately $1233 (as Table A.3 demonstrates).

Table A.3. Initial startup costs for inspection stations

Expenses	Estimated Cost
Station Certification (2-year)	$102
Inspector License	$27
Printer Purchase	$200
Printer Consumables	$200
Data Transmission Line	$20
Gas Cap Tester	$600
Tire Tread Gage	$4
Tint Meter	$80
Total	**$1,233**

To remain in business, a station's Inspection Program-related expenses would be approximately $505 per year, as Table A.4 indicates.

Table A.4. Operating expenses for inspection stations

Expenses	Estimated Cost
Station Certification	$51
Inspector License	$13.50
Printer Consumables	$200
Data Transmission Line	$20
Total	**$504.50**

In aggregate, the annual expense for the program includes 43,754 inspectors and 11,957 stations and amounts to:

$51 per year-station × 11,957 stations + $13.50 per year-inspector × 43,754 inspectors + $200 per year-station (Consumables) × 11957 stations + $240 (Data Line) per year-station × 11,957 stations = $6,461,566 per year

A.2.2. State of Texas (Continue Inspection Program)

Figure A.2 shows a graphical depiction of the revenue and expenses for the State of Texas discussed in this section.

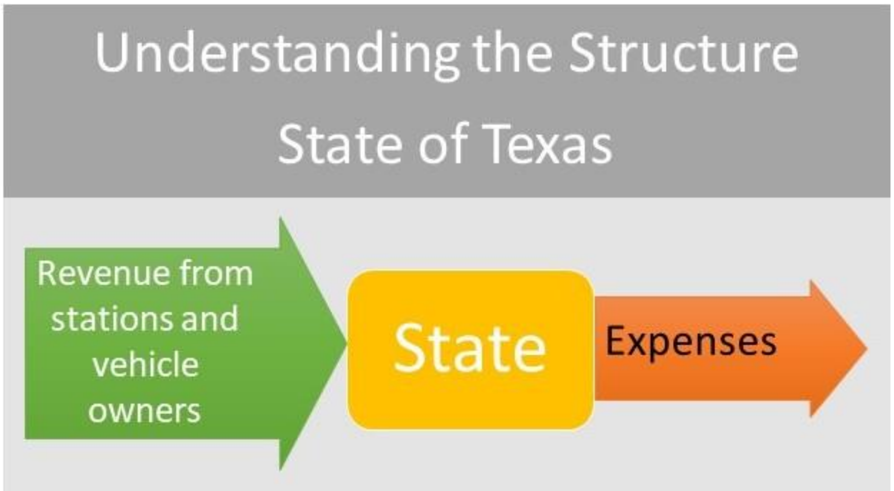


Figure A.2. Economic analysis—State of Texas

A.2.2.1. Revenue

The CTR study team identified three sources of revenue to the state.

- One-year inspection fees:
    - 18,022,169 inspections per year x 61% (vehicles in safety-only counties) × $7.50 per inspection in safety-only counties + 18,022,169 inspections per year x 39% (vehicles in emissions counties) x $5.75 per inspection in emissions counties = $122,866,137 per year
- Two-year inspection fees:
    - 1,588,773 inspections per year x 61% (vehicles in safety-only counties) × $16.75 per inspection in safety-only counties + 1,588,773 inspections per year x 39% (vehicles in safety-only counties) × $15 per inspection in emissions counties = $25,527,610 per year
- Total = $148,393,747 per year
- Station owner certification fees: 11,957 stations per year × $51 per station = $593,334 per year

- Inspector license fees: 43,754 inspectors per year × $13.50 per inspector = $590,679 per year

Thus, the total revenue is $149,577,760 per year.

As a point of interest, none of this revenue goes specifically to TxDPS for the Inspection Program.

A.2.2.2. Expenses

The CTR study team identified several areas of expenses.

1) *Cost of website, database, and troubleshooting*. A third-party vendor provides this service. Of the fees collected from vehicle owners at registration, $2.00 per vehicle in safety-only counties and $0.25 per vehicle in emissions counties goes to Texas.gov fees for the website, database, and support. This also supports functionality of the website www.Texas.gov. This same amount applies whether the inspection is for one or two years. Using calculations like A.2.2.1 above for the total fees paid at registration we get $25,837,416 per year.
2) *VIC units* (TxDIR provides VIC units to outfit new stations and replace non-functioning equipment). There are 6544 stations in safety-only counties. TxDIR reports that the service contract to deploy, troubleshoot, and replace VIC units costs $2,303,980 per year. However, this cost is covered by the Texas.gov fees and does not constitute an additional expense.
3) *Program administration*. TxDPS operates and manages the program and provides audit staff and program administration. This includes an overt and covert audit program, program administration, and staff overhead costs for the program and audit function. TxDPS reports that the audit program, program management, and overhead totaled $5,334,931 per year for FY 2017.
4) *Station signage*. TxDPS provides station signage to identify certified stations to the public. TxDPS contracts with a vendor to produce station identification signs. They recently acquired a new contract for $24.60 per sign. Their records show that in 2017 there were 1297 new stations certified. This totals $24.60 per sign × 1297 signs per year = $31,906 per year.

Thus, the total expenses are $31,204,253 per year for the state.

A.2.3. Vehicle Owner (Continue Inspection Program)

Figure A.3 shows a graphical depiction of the expenses discussed in this section for vehicle owners.

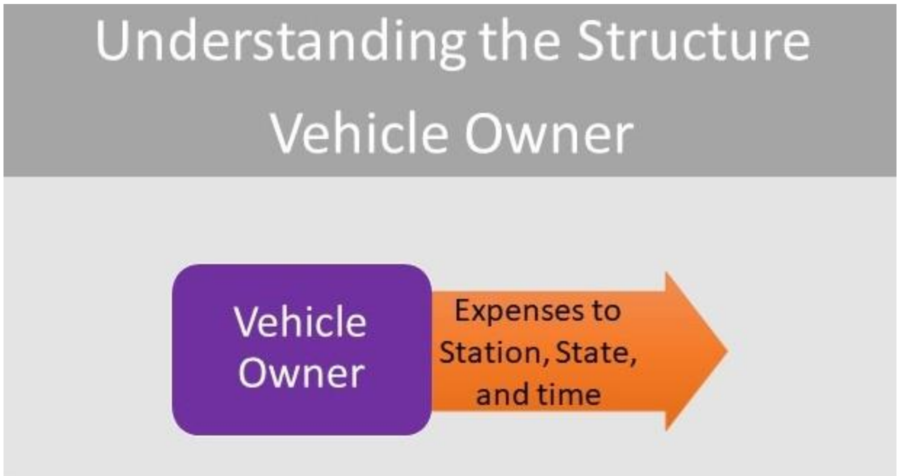


Figure A.3. Economic analysis—vehicle owner

In reviewing the costs to the vehicle owner, the CTR study team identified three categories of cost.

1) Payment to the station for the physical safety inspection fee,
2) Payment to the state at the time of vehicle registration for the safety fee, and
3) Cost of travel and waiting for inspection.

Excluded from analysis are any additional costs due to a failed inspection and subsequent repairs.

The vehicle owners' costs for the first two items are relatively easy to determine, but the cost of traveling to and from an inspection station and waiting for an inspection to be completed is harder to determine. The North Carolina Program Evaluation Division conducted a study for the North Carolina General Assembly to evaluate the North Carolina vehicle inspection program. They used a model that assumed a standard time for travel and waiting (30 minutes) and a standard value of a vehicle owner's time (one-half of the state minimum wage). If we use this same model in Texas, then we get a value of \$1.81 per year (0.5 hrs. per year × 0.5 of minimum wage × \$7.25 per hrs. minimum wage).

Further assumptions are the following:

- Cost to the vehicle owner for a two-year inspection on a new vehicle is included in the cost of the vehicle, and the vehicle owner uses no time traveling to or from and waiting at an inspection station. Thus, the two-year inspections are not included in the owner's cost.
- We can calculate the aggregate annual cost to vehicle owners using the one-year inspection (with no repair costs due to a failure).
- Owners in emissions counties must get an emissions inspection, so they would not be included in any owner's cost of traveling and waiting. They have to get the emissions inspection anyway and the safety inspection is not measurably more time. This means we need to include in this cost element only those who only get a safety inspection.

Costs for the three categories respectively would be:

1) Payment at Station = $137,276,594 per year
2) Payment at Registration = $148,393,747 per year
3) Cost for time and waiting = $1.81 per year-inspection × 11,958,334 inspections = $21,644,584 per year

This amounts to an aggregate total for vehicle owners of $307,314,925 per year.

A.3. Income and Expenses for the Inspection Program (Discontinuing the Program)

This area identifies the revenue and expenses for the station owners/inspectors, the State of Texas, and vehicle owners should the Legislature discontinue the Inspection Program.

A.3.1. Station Owners and Inspectors (Discontinue the Inspection Program)

A.3.1.1. Revenue

For the Inspection Program, the income seen in the previous section on "Income and Expenses for Parties to the Inspection Program" becomes $0. This is a loss of revenue of $137,276,594 per year for station owners by discontinuing the program.

Safety inspection of CMVs in all counties and emissions testing in emissions counties would continue, since both emissions testing of PVs and CMV safety testing is federally mandated, and remain a source of income that is outside the current study.

The 6544 stations currently in the 237 safety-only counties would derive no income from the program, and if they could not generate sufficient income from CMV safety inspections only, these stations may choose to cease operations.

A.3.1.2. Expenses

Safety inspection station owners and inspectors would technically have no expenses for discontinuing the Inspection Program.

For the record, if CMV safety inspections and emissions inspections continue, those stations conducting CMV safety inspections and stations in the emissions inspection program would continue to incur most of the costs they do now. These would be attributable to the commercial safety inspection program and the emissions inspection program and not the Inspection Program under study. Those station owners and inspectors that continue operating would have the same costs identified previously. See the previous analysis.

A.3.2. State of Texas (Discontinue the Inspection Program)

A.3.2.1. Revenue

If the Inspection Program is discontinued, revenue to the state is complicated by the continuing need for emissions and commercial safety inspections.

The revenue to the state that is collected at the time of vehicle registration would technically become $0, but since this money does not support the program directly (reference the Basis, Information, Estimates, and Assumptions section), fees may not go away. Since we do not know what legislation may be proposed, this is an unknown that we are not able to address.

Station owner certification fees for 11,957 stations and inspector license fees for 43,754 inspectors would be technically eliminated, reducing revenue to the state by $593,334 per year and $590,679 per year respectively; however, some of these would likely be continued for stations in emissions counties and safety-only county stations and inspectors where commercial safety inspection would continue. Fees from the 5413 stations in emissions counties and the corresponding inspectors needed to operate them would be an estimate of the money that would continue to come to the state. There is not a breakdown of inspectors in emissions counties, so if we used the same percentage of inspectors in emissions counties as there are percent of stations in emissions counties, we can use 19,807 continuing inspectors. This would mean that 5413 stations and 19,807 inspectors would continue paying fees. These would total 5413 stations per year x $51 per station = $276,063 per year and 19,807 inspectors per year x $13.50 per inspector = $267,394 per year. This revenue would total $543,457 per year and is a $640,556 per year reduction over current revenue.

This does not speak to the need for CMV inspections and how many safety-only county stations would continue operations to serve this need.

A.3.2.2. Expenses

Ongoing expenses identified for continuing the program would become $0, but there would be additional one-time expenses for discontinuing the program.

TxDPS has identified one-time expenses of $33,480 to change websites, databases, and interfaces and terminate contracts (identified by TxDPS in the fiscal note for SB1588).

It should be noted, however, that the emissions program is not likely to be discontinued and TxDPS is currently identified as the program administrator. They would continue to incur costs attributable to that program.

TCEQ has identified an $800,000 one-time expense for programming changes to the emissions/safety testing devices used in emissions counties to remove collection and data transfer of safety inspection information.

TxDIR has identified a one-time expense of $200,000 to retrieve all VIC units from existing locations.

These are one-time expenses and total to $1,033,480.

A.3.3. Vehicle Owner (Discontinue the Inspection Program)

Costs to the vehicle owner would become $0.

Fees paid to the stations would become $0.

Fees paid at registration would become $0, unless other fees replace them.

A.4. Summary and Additional Considerations

Developing the revenues and expenses for various parties for both continuing and discontinuing the Inspection Program is complicated. There are one-time expenses, aggregate program revenues and expenses, and there would be a loss of existing revenue to support various programs if the program is discontinued. The CTR study team has attempted to identify and account for them as best as possible.

A.4.1. Summary of Economic Analysis

The present Inspection Program represents the following revenue and costs:

- Station Owners and Inspectors
  - Revenue: $137,276,594 per year
  - Expenses: $6,461,566 per year
- State of Texas
  - Revenue: $149,577,760 per year
  - Expenses: $31,204,253 per year
- Vehicle Owners
  - Expenses: $307,314,925 per year

To discontinue the Inspection Program, the primary parties would incur these costs and savings:

- Station Owners and Inspectors
  - Revenue: $0 This represents a loss of $137,276,594 per year.
  - Expenses: $0
- State of Texas
  - Revenue: $0 This represents a loss of $149,577,760 per year.

- Expenses: $1,033,480 (one-time expense)

- Vehicle Owners
  - Expenses: $0

A.4.2. Additional Considerations

These other considerations may factor into a legislative decision:

- None of the current fees paid to the state at registration are directed to TxDPS to administer the program.
- Inspection Program fees paid to the state, collected at registration, go to support the Clean Air Fund and the Texas Mobility Fund; these programs will receive less funding on the order of $39 million and $83 million respectively. Discussions with TCEQ indicated that the current fees account for approximately 33% of funding for the Clean Air Fund.
- TxDIR pointed out that Texas.gov fees collected with most of the transactions support all the functions of www.Texas.gov as well as the safety inspection equipment deployment and troubleshooting. Loss of these fees would require replacement funding in some form. Currently this is approximately $26 million.
- If the Inspection Program were discontinued, there may not be enough commercial business to keep 12,000 inspection stations open to conduct only commercial safety inspections. Those stations in safety-only counties (with no emissions testing that brings in emissions testing fees) may face closure. This would mean loss of businesses and loss of jobs, and may also severely affect the availability of commercial safety inspections in the state.

Appendix B. Data Preparation

To extract useful information from the three large datasets used for the safety impact analysis, the study team examined the data elements carefully and pre-processed the data for final analysis. This appendix describes in detail how each dataset was prepared and pre-processed.

B.1. Crash Data Preparation

The study team obtained 2010–2017 crash records for the entire state of Texas from TxDOT Crash Record Information System (CRIS) Crash Query Tool[1]. These crash records include important information about every reportable crash, including every vehicle and person involved in each crash, which is extracted from the law enforcement officers' crash reports (CR-3 report). Important data elements include:

- Crash severity
- Number of fatalities, incapacitating, and non-incapacitating injuries
- Contributing factors
- Vehicle defects
- Vehicle type (PV, CMV [such as truck, bus, etc.], motorcycle)
- Vehicle make, model, and year
- Vehicle license plate state
- Person gender
- Person type (driver, passenger, pedestrian)
- Roadway surface condition

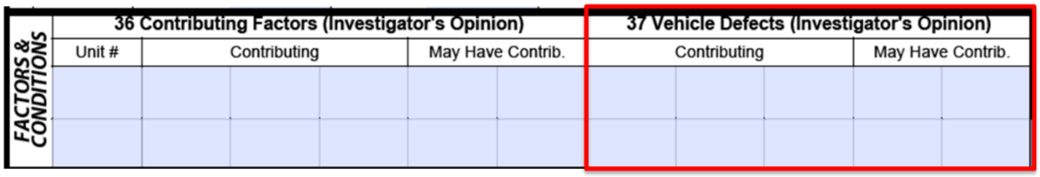
To identify crashes in which vehicle defects may have been contributing factors, the study team checked the following data columns:

- Vehicle Defect 1
- Vehicle Defect 2
- Vehicle Defect 3
- Possible Vehicle Defect 1
- Possible Vehicle Defect 2

Information in these five data columns was extracted from the item 37 in the CR-3 form, as shown in the red box in Figure B.1. Vehicle Defect 1, 2, and 3 are defects the investigator believes have

[1] https://cris.dot.state.tx.us/public/Query/app/public/welcome

contributed to the crash and Possible Vehicle Defect 1 and 2 are defects that the investigator believes may have contributed to the crash.



FACTORS & CONDITIONS	36 Contributing Factors (Investigator's Opinion)			37 Vehicle Defects (Investigator's Opinion)	
	Unit #	Contributing	May Have Contrib.	Contributing	May Have Contrib.

Figure B.1. Fields in CR-3 form containing vehicle defects information

These defect types were found in the crash data for PVs:

- Defective or slick tires
- Defective or no head/tail/stop lamps
- Defective steering mechanism
- Defective or no vehicle brakes
- Defective or no turn signal lamps
- Defective trailer hitch
- Defective or no trailer brakes
- Other (explain in narrative)

Following is the criterion the study team used to identify crashes involving vehicles with defects:

IF

None of the five vehicle defect columns has data ("No Data"), the vehicle is treated as a vehicle without any defects.

OTHERWISE

The vehicle is treated as a vehicle with a defect[2].

The data field "Commercial Motor Vehicle Flag" was used to distinguish PVs and CMVs.

B.2. TxDPS Citation Data Preparation

TxDPS maintains the Texas Highway Patrol High Value Dataset database of traffic stop citation data. This dataset is available for public access at the TxDPS website. This database includes information about each roadside traffic stop made by law enforcement officers. The study team

[2] Note that a vehicle involved in a crash might have had one or more defects based on the investigating officer's assessment. In addition, the study team combined vehicles with defects that may have contributed to a crash with vehicles with defects that contributed to a crash for this analysis. Types of defects, bad brakes, defective or slick tires, etc., are the same in either case.

downloaded 2012–2016 citation data from the TxDPS website[3]. TxDPS further provided the data for 2010 and 2011 at CTR's request. Important data elements of this dataset include, but are not limited to, the following:

- Citation issue time
- Citation issue location
- If the vehicle is a CMV or not
- Reason for stop (citation or warning)
- Vehicle type (passenger car, SUV, pickup truck, bus, etc.)
- Vehicle year, make, and model
- Weather condition
- Traffic condition
- Violation category
- Violation name

This analysis was used to identify stopped vehicles that were noted by the law enforcement officer as having one or more defects. The data field "Violation Category" was used to identify vehicles with a defect. Only vehicles with following five types of defects are included in our analysis:

- Brakes
- Lights
- Steering
- Tires/Axle/Wheels
- Windows/Film/Glazing

B.3. TxDMV Vehicle Registration Data Preparation

Through an Open Records Request, the study team obtained the vehicle registration data from 2015 through 2017 from TxDMV[4]. The dataset includes the following information about every vehicle registered in Texas from 2015 to 2017:

- Vehicle Year
- Vehicle Make

[3] Texas Highway Patrol High Value Data Sets: http://www.dps.texas.gov/director_staff/highValueDataSets.htm

[4] The study team requested vehicle title registration (VTR) data from earlier years as well, but was informed that all VTR data prior to September 2015 had been purged from the system during implementation of a new VTR data management software program.

- Body Type
- Vehicle Class

Vehicle body type was used to determine if a vehicle is a PV or a CMV. Specifically, vehicles with the following descriptions in the "BODY_TYPE" column were treated as PVs (the designation in parenthesis is the study team's interpretation of the vehicle type):

- MTRCYCLE (Motorcycle)
- PASS (Passenger Vehicle)
- PASS-TRK (Pickup Truck)
- TRK<=1 (Trucks One Ton or Less)
- NEV (Neighborhood Electric Vehicle)
- MOPED (Moped)

Vehicles with other body types are treated as CMVs.

Appendix C. Crash Costs

According to the National Safety Council's (NSC) publication *Injury Facts* (2017 edition), two methods are commonly used to measure the costs of motor-vehicle crashes: the economic cost framework and the comprehensive cost framework. According to NSC, the economic costs should not be used for a cost-benefit analysis because they do not reflect what society is willing to pay to prevent a statistical fatality or injury. Therefore, this study focuses on evaluating the comprehensive costs of those crashes involving vehicles with defects. The comprehensive costs include following components:

1) Wage and productivity losses, which include wages, fringe benefits, household production and travel delay.
2) Medical expenses, including emergency service costs.
3) Administrative expenses, which include the administrative cost of private and public insurance plus police and legal costs.
4) Motor-vehicle damage, including the value of damage to property.
5) Uninsured employer costs for crashes involving workers.
6) The value of lost quality of life associated with deaths and injuries—that is, what society is willing to pay to prevent them.

The NSC publication provides the average comprehensive costs in 2015 on a per-person basis. Their values are shown in Table C.1.

Table C.1. NSC average comprehensive motor-vehicle crash costs

Injury Severity	Comprehensive Costs, 2015
Death	$10,080,000
Disabling injury	$1,100,000
Evident injury	$304,000
Possible injury	$140,000
No injury observed	$46,500
Property damage only	$8,500

To use these costs to calculate the total comprehensive loss due to crashes involving vehicles with defects in Texas, the study team first established the following correspondence (Table C.2) between NSC injury severity types shown in Table C.1 and the injury severity types used by TxDOT in its crash database.

Table C.2. Correspondence between NSC and TxDOT injury severity types

NSC Injury Severity		TxDOT Crash Database Injury Severity
Death	....	Fatal
Disabling injury	....	Incapacitating Injury
Evident injury	....	Non-Incapacitating Injury
Possible injury	....	Possible Injury
No injury observed	....	Unknown
Property damage only	....	Not Injured and Over $1000 Damage to Any One Person's Property

Table C.3 presents the number of people killed, injured, or had property damaged in crashes involving vehicles with defects in Texas from 2015 to 2017.

Table C.3. Number of people killed or injured in crashes involving vehicles with defects

Person Injury Severity	2015		2016		2017	
	PV	CMV	PV	CMV	PV	CMV
Fatal	100	37	108	35	96	21
Incapacitating injury	433	67	499	59	478	53
Non-Incapacitating injury	1,662	167	1,880	243	2,009	183
Possible injury	2,584	240	2,997	212	2,858	288
Unknown	637	38	722	33	771	56
Not injured and over $1000 damage to any on person's property	5905	712	6586	701	6466	836

Using the counts shown in Table C.2 and the NSC crash costs shown in Table C.1, the total comprehensive costs of all crashes involving vehicles with defects in Texas are calculated and presented in Table C.4.

Table C.4. NSC comprehensive costs of crashes involving vehicles with defects

		2015	2016	2017
Comprehensive Costs	PV	$2.4 billion	$2.7 billion	$2.6 billion
	CMV	$539 million	$529 million	$376 million
	Total	**$3.0 billion**	**$3.2 billion**	**$3.0 billion**

This demonstrates that the comprehensive costs of Texas crashes involving vehicles with defects is over $3 billion and more than $2.5 billion of those costs are associated with PV crashes.

Appendix D. Defect and Non-Defect Crashes

Table D.1. Comparison between defective and non-defective PVs in terms of number of fatalities

PV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of fatalities	100	2,925	109	3,170	96	3,070
Number of vehicles in crashes	9,847	1,013,141	11,131	1,080,797	10,972	1,055,040
Fatalities per number of vehicles in crashes	**1 fatality / 98 vehicles**	**1 fatality / 346 vehicles**	**1 fatality / 102 vehicles**	**1 fatality / 341 vehicles**	**1 fatality / 114 vehicles**	**1 fatality / 343 vehicles**

Table D.2. Comparison between defective and non-defective PVs in terms of number of incapacitating injuries

PV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of incapacitating injuries	436	15,634	502	16,168	480	16,056
Number of vehicles in crashes	9,847	1,013,141	11,131	1,080,797	10,972	1,055,040
Incapacitating injuries per number of vehicles in crashes	**1 incapacitating injury / 23 vehicles**	**1 incapacitating injury / 65 vehicles**	**1 incapacitating injury / 22 vehicles**	**1 incapacitating injury / 67 vehicles**	**1 incapacitating injury / 23 vehicles**	**1 incapacitating injury / 66 vehicles**

Table D.3. Comparison between defective and non-defective PVs in terms of number of non-incapacitating injuries

PV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of non-incapacitating injuries	1,669	71,842	1,893	77,551	2,018	76,325
Number of vehicles in crashes	9,847	1,013,141	11,131	1,080,797	10,972	1055,040
Non-incapacitating injuries per number of vehicles in crashes	**1 non-incapacitating injury / 6 vehicles**	**1 non-incapacitating injury / 14 vehicles**	**1 non-incapacitating injury / 6 vehicles**	**1 non-incapacitating injury / 14 vehicles**	**1 non-incapacitating injury / 5 vehicles**	**1 non-incapacitating injury / 14 vehicles**

Table D.4. Comparison between defective and non-defective CMVs in terms of number of fatalities

CMV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of fatalities	37	583	35	560	21	588
Number of vehicles in crashes	1,102	72,837	1,080	72,881	1,273	76,048
Fatalities per number of vehicles in crashes	**1 fatality / 30 vehicles**	**1 fatality / 125 vehicles**	**1 fatality / 31 vehicles**	**1 fatality / 130 vehicles**	**1 fatality / 61 vehicles**	**1 fatality / 129 vehicles**

Table D.5. Comparison between defective and non-defective CMVs in terms of number of incapacitating injuries

CMV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of incapacitating injuries	67	1,486	59	1,389	53	1,491
Number of vehicles in crashes	1,102	72,837	1,080	72,881	1,273	76,048
Incapacitating injuries per number of vehicles in crashes	**1 incapacitating injury / 16 vehicles**	**1 incapacitating injury / 49 vehicles**	**1 incapacitating injury / 18 vehicles**	**1 incapacitating injury / 52 vehicles**	**1 incapacitating injury / 24 vehicles**	**1 incapacitating injury / 51 vehicles**

Table D.6. Comparison between defective and non-defective CMVs in terms of number of non-incapacitating injuries

CMV	2015		2016		2017	
	Defective	Non-defective	Defective	Non-defective	Defective	Non-defective
Number of non-incapacitating injuries	167	4,555	246	4,541	183	4,738
Number of vehicles in crashes	1,102	72,837	1,080	72,881	1,273	76,048
Non-incapacitating injuries per number of vehicles in crashes	**1 non-incapacitating injury / 7 vehicles**	**1 non-incapacitating injury / 16 vehicles**	**1 non-incapacitating injury / 4 vehicles**	**1 non-incapacitating injury / 16 vehicles**	**1 non-incapacitating injury / 7 vehicles**	**1 non-incapacitating injury / 16 vehicles**

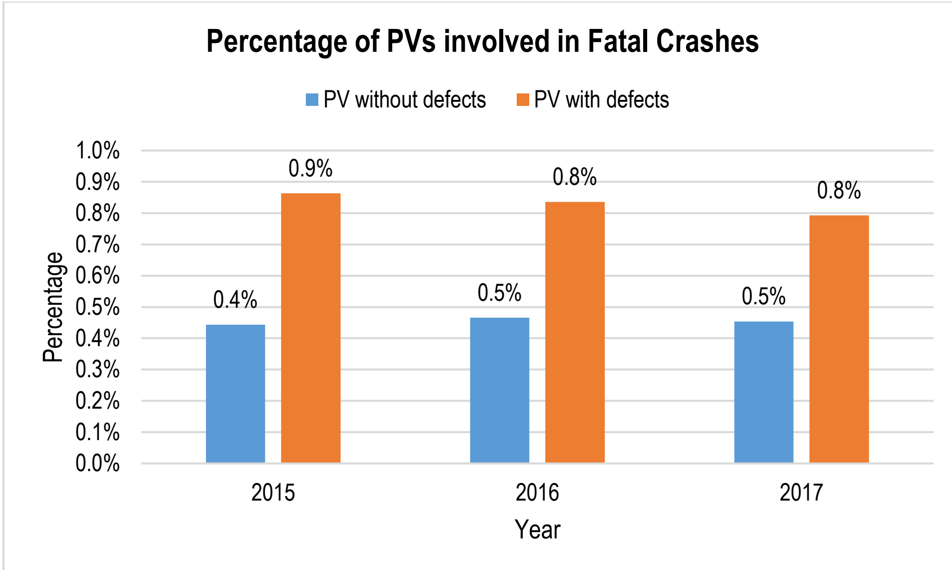


Figure D.1. Percentage of PVs with or without defects involved in fatal crashes

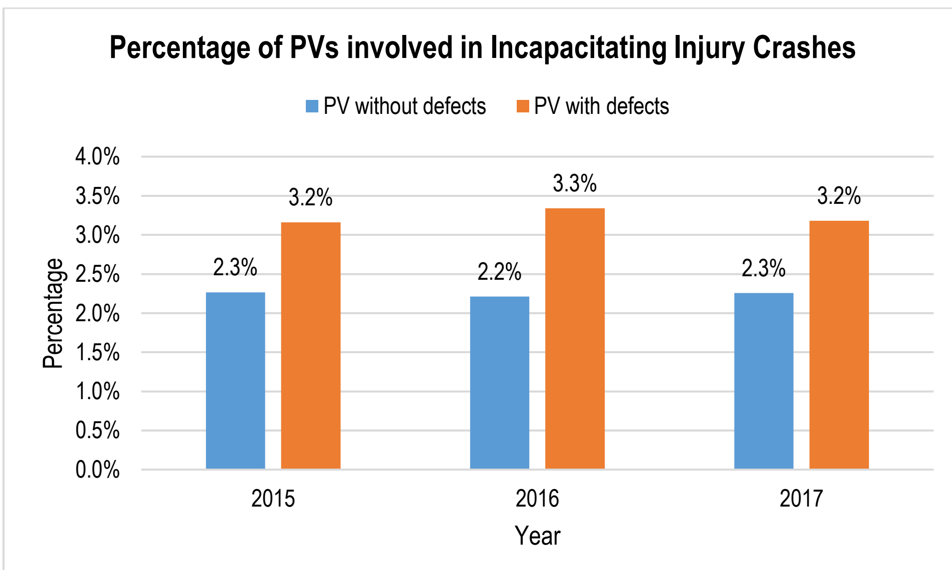


Figure D.2. Percentage of PVs with or without defects involved in incapacitating-injury crashes

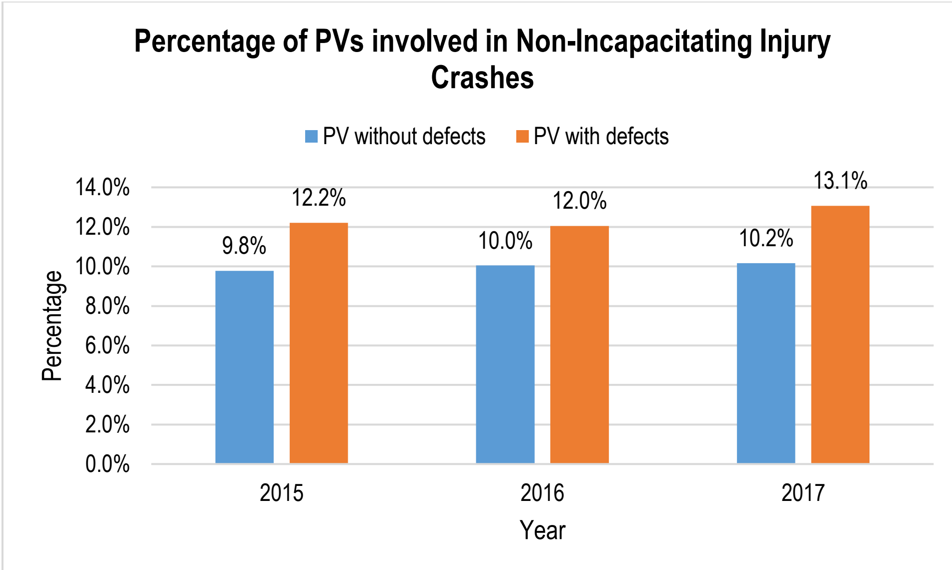


Figure D.3. Percentage of PVs with or without defects involved in non-incapacitating-injury crashes

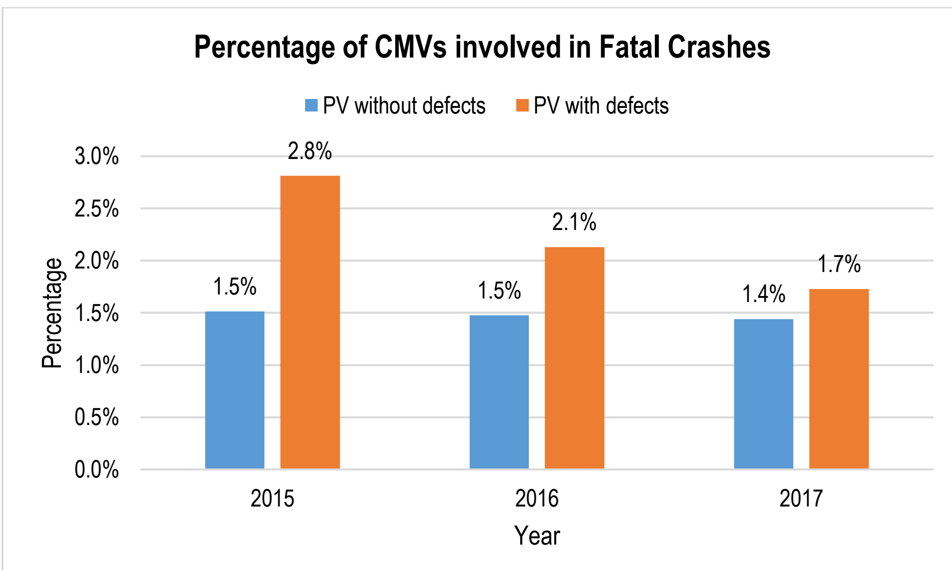


Figure D.4. Percentage of CMVs with or without defects involved in fatal crashes

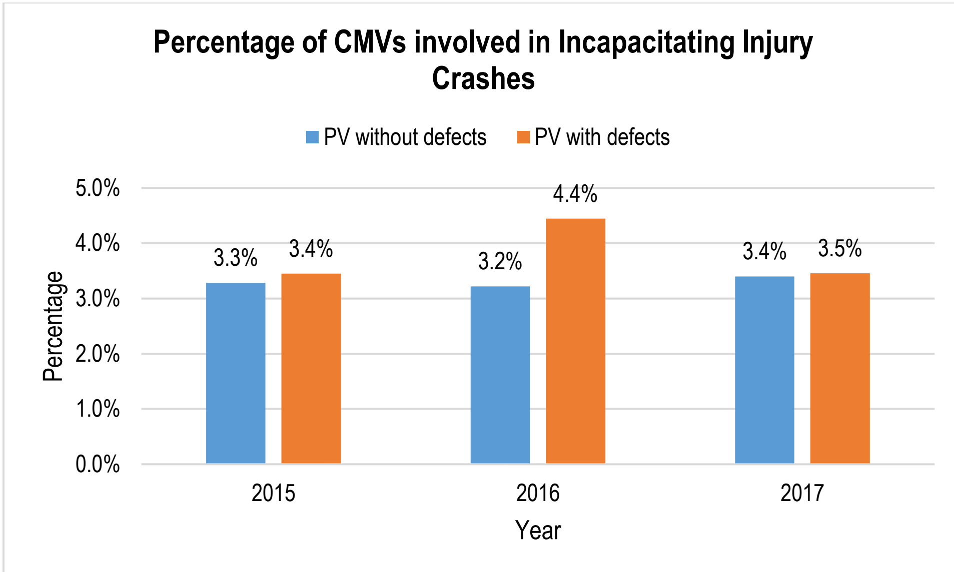


Figure D.5. Percentage of CMVs with or without defects involved in incapacitating-injury crashes

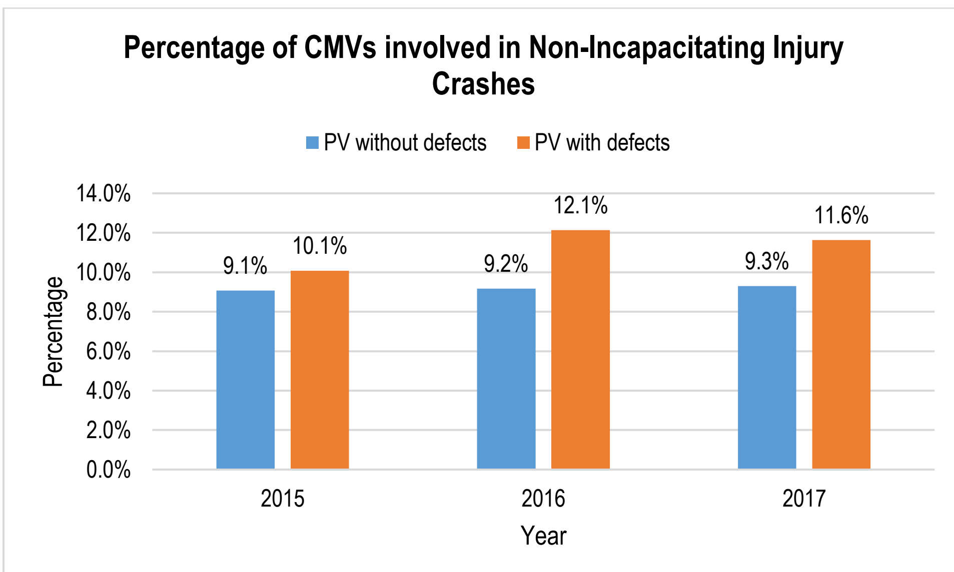


Figure D.6. Percentage of CMVs with or without defects involved in non-incapacitating-injury crashes

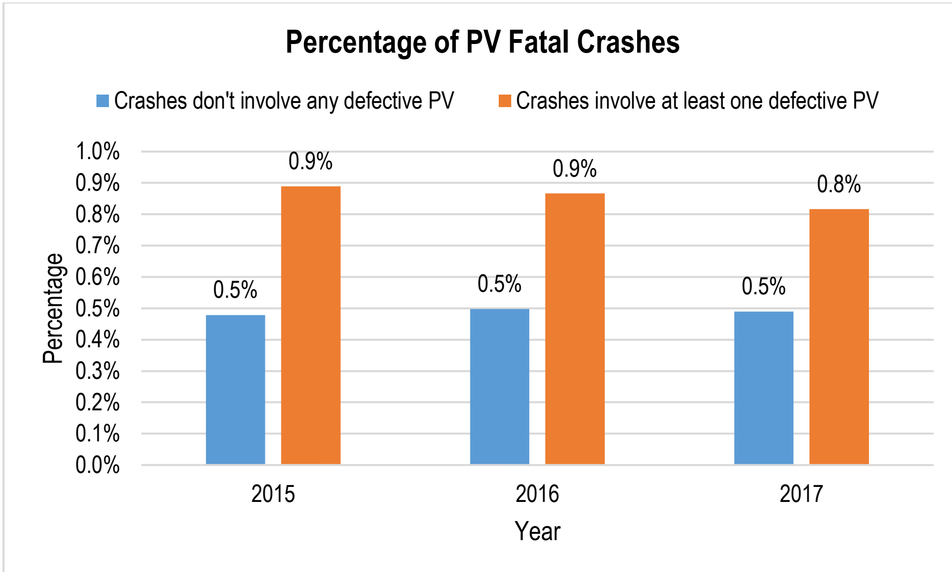


Figure D.7. Percentage of fatal crashes among all crashes involving PVs with or without defects

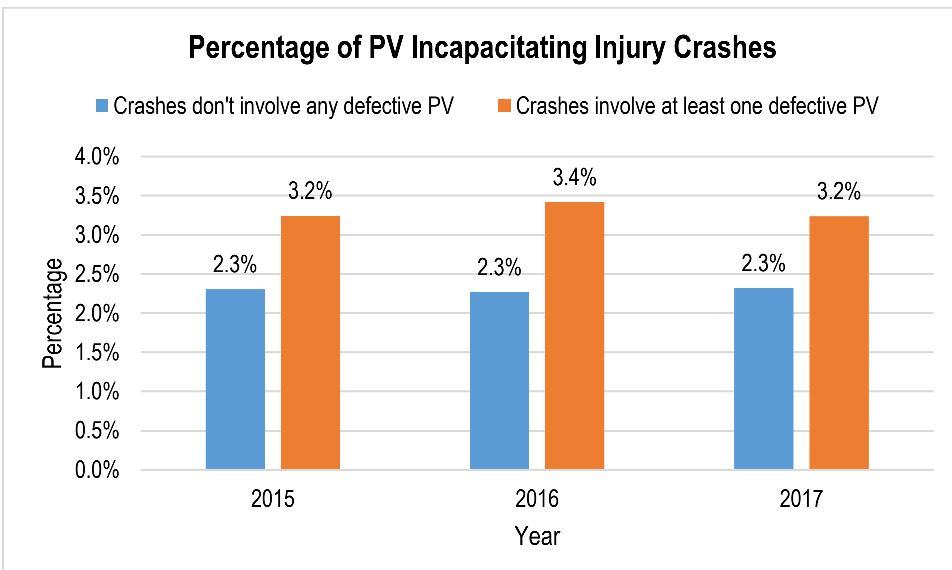


Figure D.8. Percentage of incapacitating-injury crashes among all crashes involving PVs with or without defects

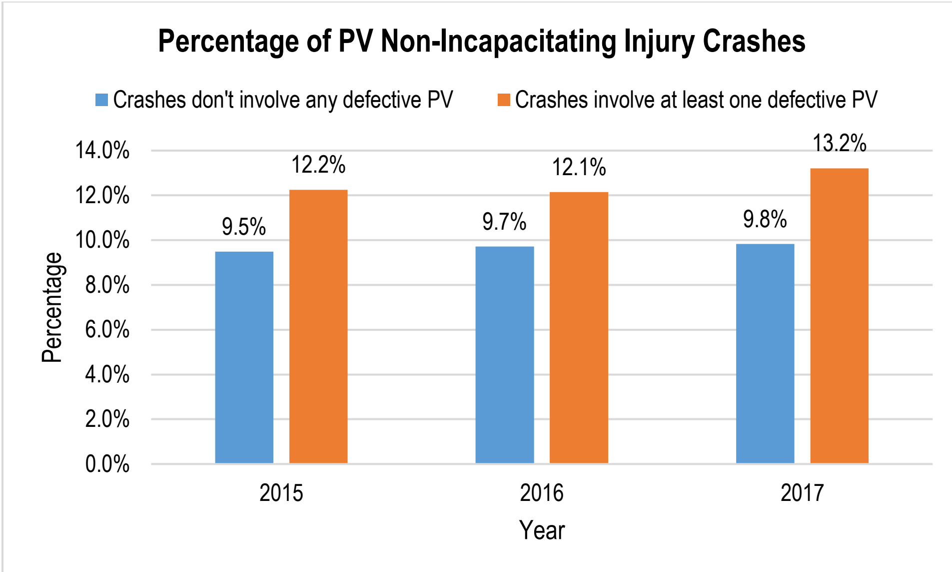


Figure D.9. Percentage of non-incapacitating-injury crashes among all crashes involving PVs with or without defects

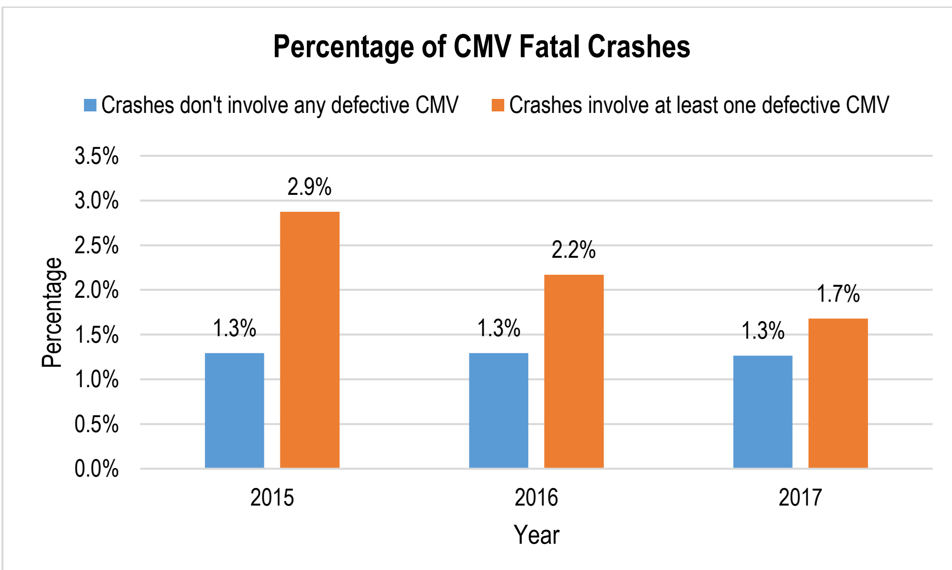


Figure D.10. Percentage of fatal crashes among all crashes involving CMVs with or without defects

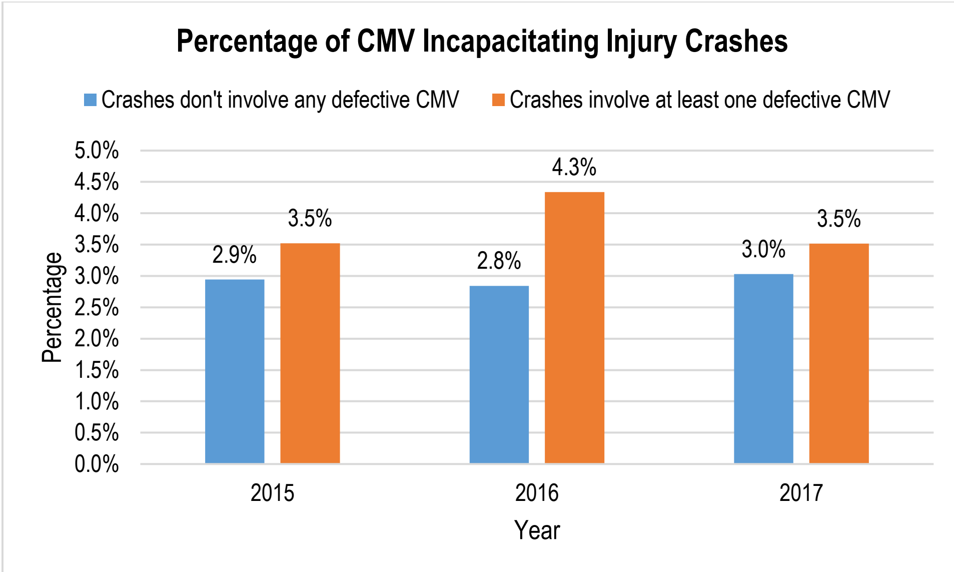


Figure D.11. Percentage of incapacitating-injury crashes among all crashes involving CMVs (defective and non-defective)

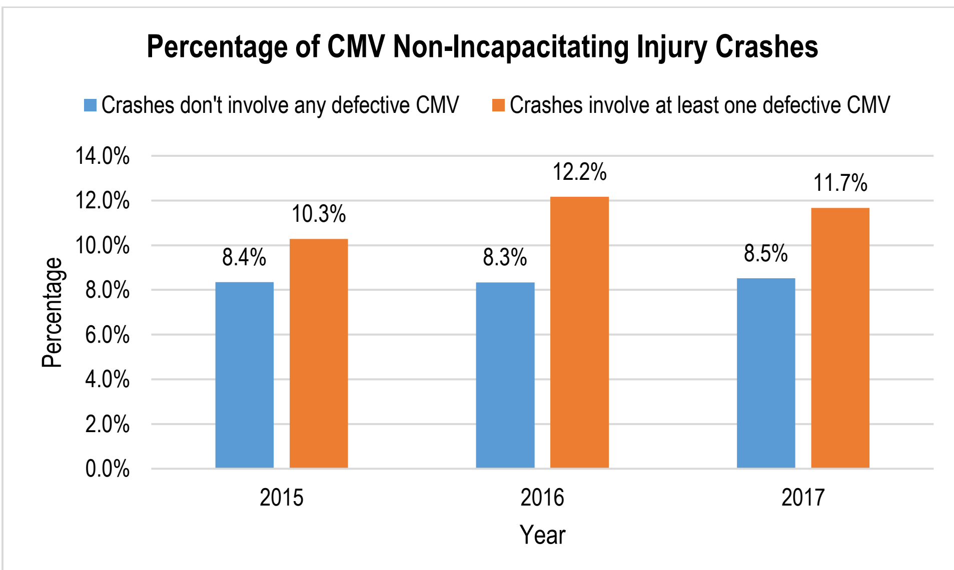


Figure D.12. Percentage of non-incapacitating-injury crashes among all involving CMVs (defective and non-defective)

Figure D.13 illustrates the distribution of Texas-licensed drivers by age in 2016, based on the information obtained from the Federal Highway Administration (FHWA, 2018). According to Figure D.13, the majority of the licensed drivers in Texas are between the ages of 20 and 64. Since no more detailed information was provided within each age group, the research team used the average age of each age group when calculating the overall average age of Texas licensed driver. For example, age 27 was used to represent the 25–29 age group, age 32 was used to represent the 30–34 age group, and so on. Consequently, the average age of Texas-licensed drivers in 2016 was found to be 46 years.

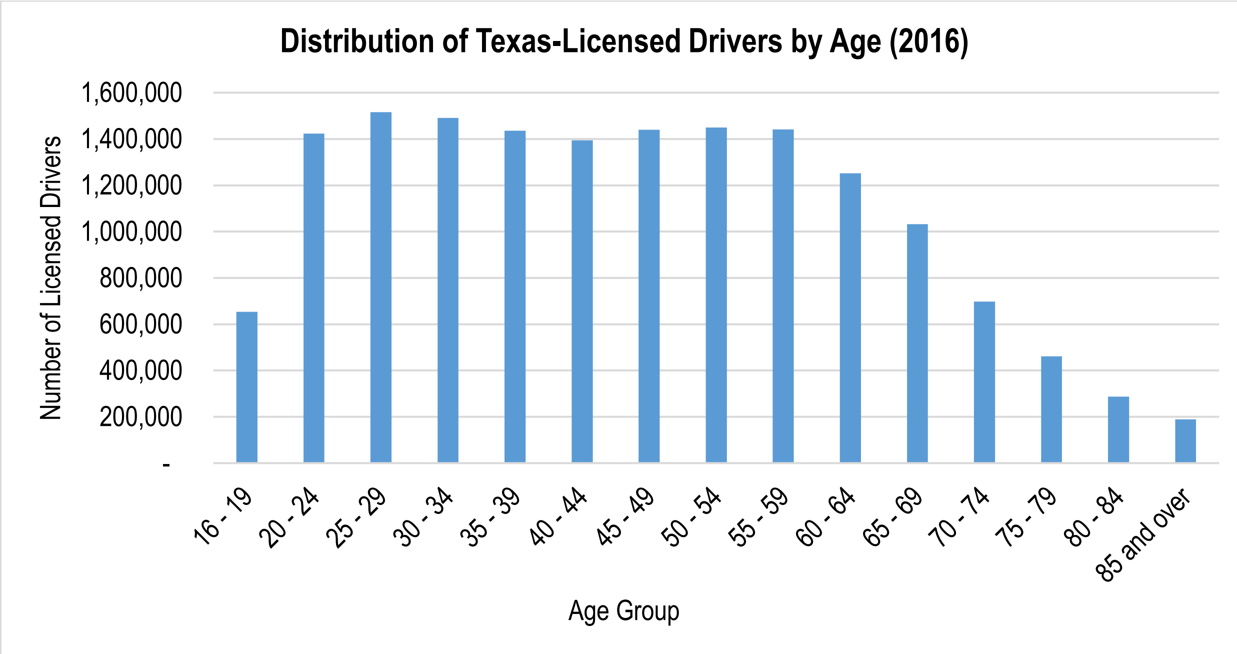


Figure D.13. Distribution of Texas-Licensed Drivers by Age in 2016

Appendix E. Crashes Involving Out-of-State Vehicles

Table E.1. Number of non-commercial vehicles coming from states that do not require vehicle safety inspection for PVs and had crashes in Texas[5,6]

State	2010		2011		2012		2013		2014		2015		2016		2017		Average percentage of defective vehicles
	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	
Alabama	486	8	479	8	579		611	4	654		806	8	809	9	796	7	0.87%
Alaska	178	1	179		193		213	1	196		219		197	2	230	2	0.36%
Arizona	1041	13	1143	11	1281	6	1340	20	1378		1622	31	1606	14	1540	20	1.03%
Arkansas	1841	25	1636	14	1812	3	1907	17	1932		2223	46	2223	38	2294	30	1.04%
California	2316	37	2265	21	2540	6	2746	32	2783		3318	64	3461	44	3428	45	1.05%
Colorado	849	7	836	2	995	4	1040	12	1032		1212	20	1338	17	1309	12	0.81%
Connecticut	101		102		137	1	161	1	169		191	1	197	1	179	1	0.37%
D.C.	32	1	25		24		43		27		50	1	49	1	51	2	1.39%
Florida	2090	28	1839	13	2094	9	2252	19	2413		2974	37	3155	39	3164	46	0.91%
Georgia	902	7	895	14	1075	2	1176	5	1243		1417	23	1507	29	1334	17	0.97%
Idaho	160	3	156	2	162		173	3	156		185	1	182	3	174	5	1.24%
Indiana	423	4	357	3	411		437	6	469		559	8	561	4	559	10	0.89%
Iowa	280	2	229	2	300	1	279	6	300		329	2	334	5	354	3	0.88%
Kansas	604	7	587	5	714	3	724	9	710		792	8	870	2	771	4	0.68%
Kentucky	216		224	3	248	1	234	1	282		290	4	301	5	308	3	0.77%
Maryland	283	4	252		319	3	327	4	383		413	2	438	4	467	8	0.84%

[5] Empty cells in these tables are 0.

[6] Mississippi and New Jersey are not included in these tables because their programs were discontinued during the study period, respectively at July 1, 2015 and August 1, 2010.

State	2010		2011		2012		2013		2014		2015		2016		2017		Average percentage of defective vehicles
	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	All	Def.	
Michigan	711	15	623	7	720	3	729	5	722		841	12	798	9	724	7	0.98%
Minnesota	357	4	334	2	342	1	369		416		421	3	428	4	394		0.46%
Montana	99		92	3	101		107	1	107		117	1	130		113	1	0.74%
Nebraska	208	5	193		235		227		223		249		266	2	260	3	0.54%
Nevada	299	5	270		307	2	292	1	316		364	3	384	4	370	2	0.63%
New Mexico	2424	32	2602	17	2752	2	2816	26	3069		3376	66	3585	76	3516	67	1.12%
North Dakota	61	2	58		79		83		105		111	2	123	2	159	2	1.00%
Ohio	554	8	515	1	563	2	580	5	651		714	6	688	7	695	6	0.70%
Oklahoma	2248	36	2075	14	2296	3	2472	25	2729		2931	35	3030	47	2997	53	0.99%
Oregon	253	5	200		235	1	249	1	260		264	2	293	3	293	2	0.66%
South Carolina	321	2	337	3	360		388	6	425		515	7	537	7	486	8	0.92%
South Dakota	102	1	103		93		94	1	100		123		115	1	122	1	0.47%
Tennessee	698	10	755	7	903	1	981	7	998		1105	22	1089	16	1102	11	0.96%
Washington	516	8	533	7	730	1	730	4	748		901	15	880	9	895	2	0.81%
Wisconsin	305	5	319	3	397	3	373	2	408		444	7	497	6	452	6	1.00%
Wyoming	106	1	120		118		129	1	139		128	1	125	1	148	2	0.58%
																Average	**0.83%**

Table E.2. Number of non-commercial vehicles coming from states that do require PV safety inspection and had crashes in Texas

States	2010		2011		2012		2013		2014		2015		2016		2017		Average percentage of defective vehicles
	All	Def	All	Def	All	Def	All	Def	All	Def	All	Def	All	Def	All	Def	
Delaware	44	1	43		51		44		73		60	2	66		76	2	1.03%
Hawaii	112		110		153		152		129		139	2	135	3	133	2	0.65%
Illinois	890	6	863	2	994	1	1090	11	1071		1251	3	1357	18	1307	14	0.58%
Louisiana	3005	66	2780	29	3419	3	3533	43	3869	2	4306	65	4566	61	4659	60	1.09%
Maine	55	1	39		61		53		58		72		60		57		0.23%
Massachusetts	171	4	163	1	208	3	256		188		299	2	280	2	277	4	0.90%
Missouri	631	4	658	2	747	3	807	7	835		1072	5	1026	22	1018	12	0.75%
New Hampshire	55	1	57		47		71		60		58		82		67	1	0.41%
New York	530	10	524	2	583		631	1	685		849	5	897	10	849	7	0.62%
North Carolina	590	4	545	3	704		702	5	737	1	948	10	899	12	936	11	0.71%
Pennsylvania	346	2	329	2	356		473	2	492		541	4	586	10	520	6	0.65%
Rhode Island	34		37		36		34		49		33		51		37		0.00%
Utah	226	5	232	1	243		279	1	256		299	7	317	2	291	6	1.00%
Vermont	25		26		35		30		22		29		41		19		0.00%
Virginia	508	5	422	1	544		575	6	582		675	12	785	7	748	6	0.72%
West Virginia	57		71		48		74		73		78	1	98	1	79	1	0.45%
																Average	**0.61%**

Appendix F. Statistical Analysis for Crashes Involving Out-of-State Vehicles

To test whether the difference between the average percentage of defective vehicles out of all vehicles for the states with or without inspection programs is significant, the study team performed statistical tests on the two groups of numbers shown in the last column of Tables E.1 and E.2 in Appendix E.

Before conducting the t-Test, an F-Test was first conducted to compare the variance of these two groups of data so that a proper t-Test can be selected. The F-Test results are shown in Table F.1. The test results indicate that with 95% confidence, we accept the null hypothesis that these two groups of data have equal variances (because the P-value is larger than 0.05).

Table F.1. Results of F-Test for variances

F-Test Two-Sample for Variances		
	Variable 1	*Variable 2*
Mean	0.006115	0.008327
Variance	0.000011	0.000006
Observations	16	32
df	15	31
F	1.86078	
P(F<=f) one-tail	**0.07044**	
F Critical one-tail	2.00301	

Based on the F-Test results, a t-Test assuming equal variances was selected to compare the means of the two groups of data from states with and without vehicle safety inspection programs. The test results, provided in Table F.2, show that the P-value (0.01) is smaller than 0.05. This means we can conclude that, with 95% confidence, the percentage of defective vehicles from states with and without the inspection requirement is significantly different. By extension, we can conclude that vehicle safety inspection programs might help to reduce the number of defective vehicles.

Table F.2. State comparison t-Test results

t-Test: Two-Sample Assuming Equal Variances		
	Variable 1	*Variable 2*
Mean	0.006115	0.008327
Variance	0.000011	0.000006
Observations	16	32
Pooled Variance	7.57E-06	
Hypothesized Mean Difference	0	
df	46	
t Stat	-2.62597	
P(T<=t) one-tail	0.00585	
t Critical one-tail	1.67866	
P(T<=t) two-tail	**0.01169**	
t Critical two-tail	2.01290	

Appendix G. Supplementary Materials for Literature Review

This appendix provides additional detailed information regarding the literature review presented in Chapter 4.

G.1. Vehicle Inspection Program Practices in Other States

The study team performed an extensive review to see how other U.S. states perform vehicle inspections. The review also revealed the priorities and differences between each state regarding vehicle inspection programs. Four states have only safety inspection programs. Eighteen states (including the District of Columbia) operate only emission inspection programs. Fourteen states maintain both safety inspection and emission inspection programs. The other fifteen states do not have either safety or emissions inspection programs. In other words, a total of eighteen states maintain a safety inspection program and thirty-two states operate an emission inspection program.

More detailed information on each state's inspection program is summarized and listed in Table G.1, including inspection program type, inspection frequency, and cost.

Table G.1. Vehicle inspection programs in different U.S. states[7]

State	Vehicle Types	Safety Inspection	Emission Inspection	First Inspection (Vehicle Age)	Inspection Frequency	Cost
Alabama	All vehicles	✓	-	Prior to sale or transfer of ownership	-	-
Arizona	Vehicles in selected counties	-	✓	Upon registration. Phoneix and Tucson metro only.	Biennial	-
California	Vehicles in selected counties	-	✓	Upon registration. Required in 41 counties.	Biennial	-
Colorado	Vehicles in selected counties	-	✓	Upon registration. Required in nine counties.	-	$15–25
Connecticut	All vehicles	-	✓	Upon registration	Biennial	$20
Delaware	All vehicles	✓	✓	Upon registration	Biennial	Free
District of Columbia	All vehicles	-	✓	Upon registration	Biennial (PV), annual (CMV)	-
Georgia	Vehicles in selected area	-	✓	Upon registration. Required for Atlanta metro.	Annual	$25
Hawaii	All vehicles	✓	-	Upon registration	Annual	$15–20
Idaho	Vehicles in selected counties	-	✓	Emission inspection required for Ada and Canyon counties	Biennial	$11
Illinois	Vehicles in selected counties	-	✓	Emission inspection required for Chicago and St. Louis metros. Vehicle older than four years.	Biennial	-
Indiana	Vehicles in selected counties	-	✓	Upon registration. Required for Lake and Porter counties.	Biennial	$40
Louisiana	All vehicles	✓	✓	Upon registration. Emission inspection is required for Baton Rouge metro.	Annual	$18
Maine	Most vehicles	✓	✓	Emission inspection is required for Cumberland county only	Annual	$12.50

[7] States not listed in this table do not have either safety or emission inspection programs.

State	Vehicle Types	Safety Inspection	Emission Inspection	First Inspection (Vehicle Age)	Inspection Frequency	Cost
Maryland	Used vehicles	✓	✓	Upon transfer. Emission inspection is required biennially for 13 counties and Baltimore.	-	-
Massachusetts	All vehicles	✓	✓	-	Annual	$35
Missouri	All vehicles	✓	✓	Emission inspection is required for St. Louis metro	Biennial	$10–12
Nebraska	All out-of-state vehicles	✓	-	Upon registration for out-of-state vehicles	-	$10
Nevada	Vehicles in selected counties	-	✓	Only for urban areas of Clark and Washoe counties	Annual	-
New Hampshire	All vehicles	✓	✓	Upon registration	Annual	$20–50
New Jersey	Most vehicles	-	✓	Upon registration. Exempt for first five years, then biennially.	Biennial	-
New Mexico	Certain vehicles	-	✓	-	Biennial	-
New York	All vehicles	✓	✓	Upon registration. Emission inspection is required for 48 counties.	Annual	$6–25
North Carolina	All vehicles	✓	✓	Upon registration	Annual	$43.60
Ohio	Vehicles in selected counties	-	✓	Emission inspection is required for Cleveland metro	Biennial	$18
Oregon	Most vehicles	-	✓	Upon registration. For Portland and Medford metros only.		$10–21
Pennsylvania	All vehicles	✓	✓	Emission inspection is required in 25 counties	Annual	-
Rhode Island	Most vehicles	✓	✓	Upon registration	Biennial	$55
Tennessee	Vehicles in selected counties	-	✓	Emission inspection is required for selected Nashville counties/Chattanooga area	Annual	-

State	Vehicle Types	Safety Inspection	Emission Inspection	First Inspection (Vehicle Age)	Inspection Frequency	Cost
Texas	All vehicles	✓	✓	Upon registration. Emission inspection is required in 17 counties.	Annual	$14.5–62
Utah	Vehicles in selected counties	-	✓	Emission inspection is required for the top four populated counties	-	-
Vermont	All vehicles	✓	✓	-	Annual	$35-50
Virginia	All vehicles	✓	✓	Upon registration. Emission inspection is required in urban and suburban northern Virginia.	Annual (safety), biennial (emission)	$12–51
Washington	Most vehicles	-	✓	For urban areas of selected counties	Biennial	$15
West Virginia	Most vehicles	✓	-	-	Annual	$14.66
Wisconsin	All vehicles	-	✓	Emission inspection for selected counties. After the vehicle is three years old.	Biennial	-

G.2. Vehicle Inspection Program Practices in Other Countries

Vehicle inspection programs are carried out in many countries around the world. A variety of vehicular systems are checked, and tests are performed to evaluate a vehicle's risk for crash and contribution to emissions. Table G.2 lists the vehicle components inspected during safety inspections worldwide.

Table G.2. Vehicle components inspected during safety inspections worldwide

Exhaust system	Engine	Suspension
Steering	Electrical systems	Tires
Windshield wipers	Defrosters	Bodywork
Brakes	Lighting	Signaling devices
Wheels	Structure	General components
Seat belts	Driver's view	Fuel systems
Speedometer	Headlamp	Undercarriage
Airbags	Mirrors	Bumpers
Fenders	Seats	Doors
Horn	Engine lights	Filler neck restriction
Warning devices	Chassis	

Because different countries have different implementing regulations and policy goals, the study team investigated how different countries perform vehicle inspections. The literature review revealed the current practices of inspection programs in other major countries, summarized in Table G.3.

Table G.3. Vehicle inspection programs in other countries

Country	Inspection Criteria	Safety Check	Emission Check	First Inspction (Vehicle Age)	Inspection Period	Cost
Australia	All motorized vehicles; inspection standards depend on states	✓	-	Upon registration	Annual	-
Canada	Imported vehicle and cars to be sold; CMVs in some areas	✓	✓	Varies among provinces	-	-
UK	Motorized vehicles	✓	✓	-	Annual	£54.85 ($72.63)
France	All motorized vehicles, optional for motorcycles	✓	✓	4 years	Biennial for safety; annual for emission	-
Hong Kong	All vehicles	✓	✓	6 years	-	-
Italy	All automobiles	✓	-	4 years	Biennial	-
Japan	All cars and motor vehicles	✓	-	Upon registration	1–3 years, depending on vehicle type	-
Malaysia	Company registered and private vehicles	✓	✓	-	Annual	-
New Zealand	Cars	✓	-	-	Annual if vehicle is younger than 6 years; 6 months if older	-
Singpore	All vehicles	✓	✓	3 years	Biennial	-
Spain	Cars, motorcycles, and quad bikes	✓	-	4 years	Biennial until 10 years of age; annual if older	-
Switzerland	Cars and motorcycles	✓	✓	4 years	Biennial	56–150 CHF ($56.29–150.77)
Thailand	Cars and motobikes	✓	✓	7 years, 5 years, respectively	Annual	-

G.3. Past Research on the Effectiveness of Inspection Programs

G.3.1. Involvement of Vehicle Defects in Crashes

This section provides the detailed review of studies that were included in Table 2.1 in Chapter 2.

- *McLean, A.J., Brewer, N.D., Hall, T., Sandow, B.L., & Tamblyn, P.J. (1979). Adelaide In-depth Accident Study. Part 4: Motorcycle accidents. The University of Adelaide.*
- *McLean, A.J., Aust, H.S., Brewer, N.D., & Sandow, B.L. (1979). Adelaide In-depth Accident Study. Part 6: Car accidents. The University of Adelaide.*

The researchers from the University of Adelaide conducted a series of observational studies to investigate the role of vehicle defects in an accident. A sample of accidents, where an ambulance was called in the Adelaide metropolitan area, was investigated at the scene by a multi-disciplinary team from the Road Accident Research Unit of the University of Adelaide over a 12-month period from March 1976. An engineer, a psychologist, and a medical officer investigated each accident. The observations began on average 10 minutes after the ambulance was called and were supplemented by follow-up investigations, including interviews with people involved in the accidents, observation of uninterrupted traffic behavior at the same time of day as the accident, inspection of crashed vehicles at towing sites, and detailed examination of the accident site.

A total number of 304 accidents were observed, which involved 386 vehicles. Of the 386 cars examined, eleven (2.8%) were found to have defects identified as significant contributing factors and three (0.8%) in which the defect was definitely the major factor in the causation of the accident. Tires were the most common defects detected. The results of these studies indicate that vehicle defects are significant contributing factors to a small portion (2.8%) of accidents.

- *Haworth, N., R. Smith, I. Brumen and N. Pronk. 1997a. Case-control study of motorcycle crashes. Report CR 174, Federal Office of Road Safety, Australia*

Haworth et al. (1997a) conducted a case-controlled study of 222 motorcycle crashes in the Melbourne metropolitan area from late November 1995 to January 30, 1997. In these crashes, either the rider or the passenger was taken to the hospital or died. The controls were 1,195 motorcyclist trips that passed the crash site at the same time of the day and day of the week the crash occurred. It was found that mechanical faults contributed to about 12% of crashes overall. The authors also noted that the proportion was much higher for single-vehicle crashes, at 28%. The incidence of defects contributing to multi-vehicle crashes was 7%.

- *Haworth, N., P. Vulcan, L. Bowland, and N. Pronk, 1997b. Estimation of Risk Factors for Fatal Single Vehicle Crashes. Reports No. 121, Monash University Accident Research Centre, Australia.*

Haworth et al. (1997b) conducted a case-controlled study of fatal single-vehicle crashes in Victoria from December 1, 1995 to November 30, 1996. The cases are fatal crashes with information on driver and passenger, vehicle characteristics, and location. The controls are trips without crashes that also have information on driver and passenger, vehicle characteristics, and location. Of all the crashed cars, 37% had defects that rendered them un-roadworthy. In addition, it was found that mechanical defects contributed to 3% of crashes. Tire and brake problems were the most common defects.

The researchers also found that drivers over age 60 and under 25 experienced a higher risk of being involved in a fatal single-vehicle crash than drivers aged between 25 and 59. In particular, drivers aged over 70 (including 70) and under 21 had the greatest risks.

- *Grandel, J. (1985). Investigation of the technical defects causing motor vehicle accidents. Field Accidents: Data Collection, Analysis, Methodologies, and Crash Injury Reconstructions. SAE International Congress and Exposition, Detroit, February 25-March 1, 1985.*

German law requires that all the accidents involving fatality, injury, or severe property damage need to be reported and examined. The German Motor Vehicle Inspection Association (DEKRA) analyzes the technical defects found during the inspection of vehicles after accidents regarding the causing potential. Each accident vehicle is examined as soon as possible after a crash. An engineer who has been specially trained to detect defects in crashed vehicles conducts the inspection. In addition to the standard accident data, details on the causes of accidents were collected.

Grandel (1985) applied DEKRA data to present a collective analysis describing which vehicle components are considered to be the causes of accidents. He found that over half of the vehicles inspected had defects. The results of the study indicate that 6.5% of passenger cars and 5% of two-wheeled vehicles (including motorbikes, mopeds, and motorized bicycles) involved in crashes had defects that may have contributed to the crash. The most common defects that contributed to accidents are brake components and tires.

- *Masui, J., Sasaki, A., Urano, T. 1982. Legal system of Japan on motor vehicles. Part 5; Technical Sessions. SAE Report No. 826109.*

According to Masui et al. (1982), in Japan, drivers are expected to examine their own vehicles every day, and follow up with a more thorough (usually professional) check monthly, or biannually. Therefore, the statistics regarding the vehicle defects contributing to accidents is low. About 1.3% of accidents in Japan are attributable to vehicle defects (Masui et al., 1982; Rechnitzer et al., 2000).

- *Treat, J.R., 1977. Tri-level study of the causes of traffic accidents: an overview of final results. In Proceedings: American Association for Automotive Medicine Annual Conference (Vol. 21, pp. 391-403). Association for the Advancement of Automotive Medicine.*

The Institute for Research in Public Safety (IRPS) conducted an in-depth study of car accidents in Monroe County, Indiana, from the period of August 1972 to June 1977. In the report, the term ‘cause’ was defined as a deficiency but for which an accident would not have occurred. The researchers investigated the accident immediately after the crash and they conducted this independently from the police. The vehicles were inspected briefly, physical evidence was collected, and the drivers were interviewed at the accident scene. The technicians also made clinical assessments of the causes of the accident. Of 2,258 accidents investigated, a subset of 420 were investigated in greater depth by a multidisciplinary team of professionals. Sample selection for this section was based on the willingness of subjects to participate. An automotive engineer at the IRPS inspection facilities inspected these vehicles.

Treat (1977) noted that many causes might contribute to one accident at the same time, such as the vehicle defects, the environmental issues, and the driver factors. Based on the investigation results of the multidisciplinary team and on-site teams, human factors were cited as probable causes in 93% of accidents, compared to 34% for environmental factors and 13% for vehicular factors. Leading human factors included excessive speed, improper lookout, inattention, and improper evasive action. Slick roads and view obstructions were leading environmental factors. In terms of the vehicle defects, the most common defects that had caused accidents were the braking system (2.9% to 5.2%), tires and wheels (0.5% to 4%), communication systems such as lights and glazed surfaces (0.2% to 1.7%), steering systems (0.2% to 1%), and body and doors (0.5% to 0.7%). Vision (especially poor dynamic visual acuity) and personality (especially poor personal and social adjustment) were also related to accidents.

- *Fazzalaro, James. Periodic Motor Vehicle Safety Inspections. Connecticut General Assembly Office of Legislative Research. October 2007.*

Factors contributing to accidents in Connecticut appear to be overwhelmingly behavioral (driver-related) or environmental (road or weather conditions). According to accident data compiled by the Department of Transportation, of the approximately 80,000 reported accidents that occur in Connecticut each year, mechanical failure of a vehicle is listed as a contributing factor in only about 0.7% of accidents, 0.6% of the injury-producing accidents, and 0.35% or less of the fatal accidents. Unsafe or failed vehicle tires are typically listed as a contributing circumstance in 0.35% of all accidents, 0.2% of injury-producing accidents, and 0.33% or less of fatal accidents. Thus it appears that these vehicle-related factors taken together are shown as contributing factors in only about 1% of reported accidents in Connecticut each year.

- *Rompe, K. and Seul, E., 1985. Advantages and disadvantages of conducting roadworthiness tests to monitor the mechanical condition for private cars, the impact of such tests on road safety, environmental protection and the renewal of the vehicle fleet and the scope for introducing roadworthiness testing throughout the European community. Final report commissioned by the Directorate-General for Transport. VII/G-2 of the Commission of the European Communities. Drawn up by the TUV Rheinland.*

Rompe and Seul (1985) found that several in-depth studies have concluded that vehicle defects have directly or substantially contributed to approximately 3% to 24% of all crashes. In terms of the effectiveness of inspection programs, they noted that about 50% of the accidents caused by vehicle defects could be reduced by periodic vehicle inspections, based on the results of one cautious and accurate U.S. survey (Rechnitzer et al. 2000).

Both Vaughan (1993) and Rompe and Seul (1985) found that the occupants are more likely to be killed if involved in crashes associated with older cars. This is due to several reasons: older vehicles have more vehicle defects due to deterioration; older cars provide lower levels of occupant protection than newer cars do; and newer vehicles provide improved safety features.

- *Manitoba Infrastructure, 2018. Online reference. The official website of Manitoba Province, Canada. http://www.gov.mb.ca/mit/mcd/mcs/index.html. Retrieved on June 22, 2018.*

The province of Manitoba published the Commercial Vehicle Safety Alliance (CVSA) inspection report from 2008 to 2017, where the failure rate for 2017 inspection is 30.61%. The failure rate has kept increasing since 2013. The failure rate from 2008 to 2017 is presented in Figure G.1. The most common failure factor is brakes.

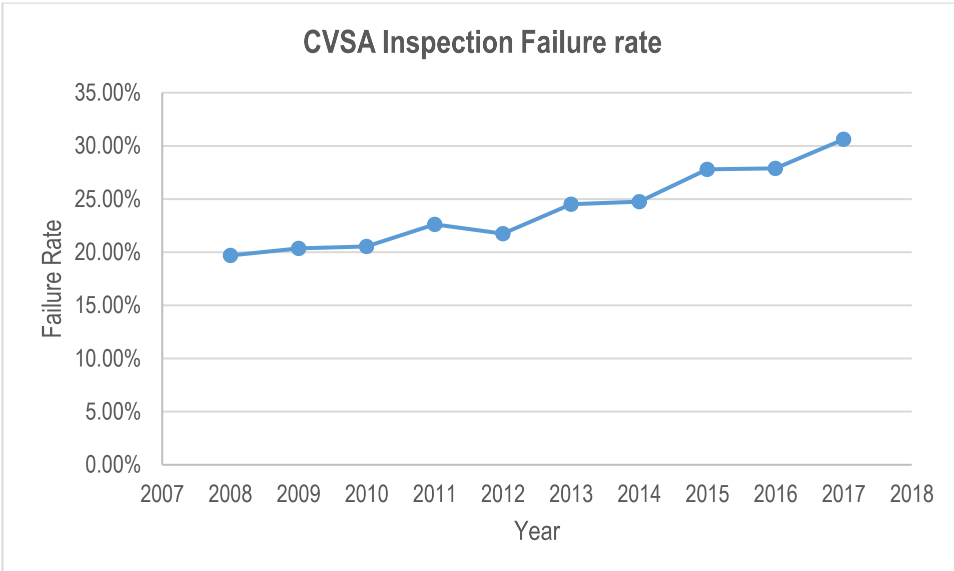


Figure G.1. CVSA inspection failure rate reported by Manitoba Province

G.3.2. The Effect of Vehicle Age in Crashes

During the past several decades, several studies have investigated the effect of vehicle age in crashes. In general, they found that older vehicles are more likely to be involved in a crash. This is due to three possible reasons:

1) Vehicle components deteriorate over time. Older vehicles may be in poorer conditions than newer cars.
2) Updated vehicle designs and construction make newer vehicles safer overall, providing higher levels of occupant protection than older cars do.
3) The types of people driving older cars may differ from those driving newer cars (Vaughan, 1993; Youngman and Stolinski, 1994).

Table G.4 lists the studies examining the relationship between vehicle age and crashes (Rechnitzer et al., 2000).

Table G.4. Summary of studies examining relationship between vehicle age and crashes

Authors	Findings	Implications
Treat (1977)	Cars older than eight years were twice as likely to crash as a result of vehicle factors than for all cars.	Older cars are more likely to crash as a result of vehicle defects.
Jacobson (1982)	Driver compensation may result in no increase in non-emergency accident rate in older cars. Crash tests of two corroded cars revealed little structural resilience in corroded sections of the car body.	Older cars are not necessarily at higher risk of non-emergency accidents. Corroded vehicle bodies offer little structural resilience.
Vaughan (1993)	Older cars are in more crashes than younger cars.	Older cars are more likely to crash.
Motoring Directions (1998)	Older cars are in more crashes than younger cars.	Older cars are more likely to crash.

- *Treat, J.R., 1977. Tri-level study of the causes of traffic accidents: an overview of final results. In Proceedings: American Association for Automotive Medicine Annual Conference (Vol. 21, pp. 391-403). Association for the Advancement of Automotive Medicine.*

After investigating more than 2000 car accidents in Monroe County, Indiana, Treat (1977) found that older cars with mechanical problems were over-involved in accidents. Treat concluded that the probability of an accident-involved vehicle eight years or older being cited for a causative vehicular problem was more than two times greater than for accident-involved vehicles in general.

- *Vaughan, R., 1993. Vehicle ageing and safety. In Wheels '92: Conference and Workshop; Proceedings (p. 47). Institution of Engineers, Australia.*

Vaughan (1993) analyzed New South Wales crash data from 1977 to 1991 (inclusive) in which occupants of passenger cars were killed. Vaughan found that the occupant death rate per 100 million kilometers (62.1 million miles) of travel in older cars has consistently been the highest in all vehicle age categories. This trend is supported by the findings from other research conducted in other countries, including the USA (NHTSA, 1989), Sweden (Rechnitzer et al., 2000), and Germany (Grandel, 1985).

- *Motoring Directions. (1998). Arresting the ageing of Australia's vehicle fleet. Motoring Directions, 3(4), 8-11.*

This study was conducted by representatives of federal and state road, transport authorities, motoring organizations, the automotive manufacturing, retail industries, and independent road safety experts. They found that older vehicles were over-represented in crashes where deaths and serious injuries occur. For a pre-1970 model year vehicle, the risk of being injured in a crash is double that for a 1990 model year vehicle. It needs to be pointed out that this study focused more on the effect of newer cars with improved safety features as the reason why newer cars have a lower crash rate, rather than the contribution of the defects in the older cars.

- *Jacobson, M.A. (1982). Accident avoidance: How age deterioration can affect car safety. SAE Report No 826100. Experimental Safety Vehicles; Section 5: Technical Sessions.*

Jacobson (1982) noted that there is a progressive deterioration with age and mileage of steering, suspension, and brakes. Tires also deteriorate with time. However, Jacobson questioned if there is enough reliable data to quantify the number of older or badly maintained cars that are experiencing higher risks due to vehicle defects. He suggested that driver factors were the main causation of the crashes. Jacobson found that deterioration of older cars does not necessarily contribute to the incidence of accidents in most of cases due to driver factors.

G.3.3. Safety Effectiveness of Inspection Programs

This section lists the detailed review on studies that were included in Table 2.2 in Chapter 2.

- *Peck, D., Matthews, H.S., Fischbeck, P. and Hendrickson, C.T., 2015. Failure rates and data driven policies for vehicle safety inspections in Pennsylvania. Transportation Research Part A: Policy and Practice, 78, pp.252-265.*

Peck et al. (2015) combined Pennsylvania vehicle registration data with two large samples of results from state safety inspections. They used a logistic regression model to determine if any independent variables of vehicle characteristics are statistically significant in predicting the dependent variable of vehicle safety inspection outcome (whether a vehicle will pass or fail inspection). After a series of analyses, the authors found that the state of Pennsylvania safety inspection fail rate for light-duty vehicles is 12–18%, well above the often-cited rate of 2%. In addition, vehicles that are older than three years or have more than about 30,000 miles can have much higher rates. They also pointed that accurate inspection data is limited and often incorrectly analyzed. They concluded that the importance of vehicle maintenance over a vehicle's lifetime is evident, and that vehicle safety inspections should continue to be implemented in order to keep driving conditions safe.

- *GAO, 2015. United States Government Accountability Office. Vehicle Safety Inspections. Improved DOT Communication Could Better Inform State Programs. Report to the Honorable Claire McCaskill, U.S. Senate. Report No. GAO-15-705*

In a report published by the United States Government Accountability Office (GAO, 2015), Pennsylvania state data show that in 2014, about 20% of vehicles in the state failed inspection and then underwent repairs to pass, which is well above the often-cited 2%. In addition, a before-and-after analysis of Oklahoma and New Jersey was conducted. The state of Oklahoma eliminated its safety inspection program in 2001 and New Jersey eliminated theirs in 2010. Data on the number of crashes recorded in the state and the number of crashes recorded with vehicle component failures before and after the program elimination was collected. Data from 1995 to 2013 was obtained for Oklahoma and data from 2005 to 2013 (three years after the elimination) was obtained for New Jersey. The authors also analyzed national level crash data from NHTSA's National Automotive Sampling System General Estimates System (NASS-GES) for the years 2009–2013. The purpose was to determine the estimated number of total crashes with vehicle factors nationwide as well as the specific vehicle component failures that were reported, such as issues with brakes, tires, and steering. In both instances, crashes involving vehicle component failure were generally between 2 and 3% of all crashes and varied little from year to year, even after the elimination of the inspection programs. The crash rate was also calculated with controlling for vehicle miles traveled. The results also indicated that the rate did not significantly change for either state. However, the authors note that this analysis does not provide sufficient evidence to conclude that inspection programs did not have an effect on crash rates because additional factors—such as implementation or increased enforcement of traffic safety laws—could influence crash rates

- *Keall, M.D. and Newstead, S., 2013. An evaluation of costs and benefits of a vehicle periodic inspection scheme with six-monthly inspections compared to annual inspections. Accident Analysis & Prevention, 58, pp.81-87.*

Keall and Newstead (2013) evaluated the safety impact of doubling the inspection frequency, from annual to biannual, when the vehicle reaches six years of age. Reductions in safety-related vehicle faults were estimated together with the value of the safety benefits compared to the costs. They analyzed merged crash data (2004–2009), licensing data (2003–2008), and roadworthiness inspection data (2003–2009) provided by the New Zealand Ministry of Transport and the New Zealand Transport Agency. These three data sets were merged for each year available using the registration plate number to match crash and licensing data and a unique vehicle identification number to then link these data to the inspection data. There were estimated to be improvements of 8% (95% CI 0.4–15%) in injury crash involvement rates and 13.5% (95% CI 12.8–14.2%) in prevalence of safety-related faults associated with the increase from annual to six-month inspections.

It is noteworthy that the periodic vehicle inspection regime in New Zealand is referred to as the warrant of fitness (WoF) scheme. Vehicles are required to be inspected every year up until six years since manufacture and thereafter every six months. The following figures present some statistical findings of the study. Only vehicles sold new in New Zealand are analyzed to avoid distortions to the time series associated with vehicles introduced into the fleet from other countries (mainly Japan) where different schedules of mechanical maintenance and different degrees of wear and tear associated with road conditions may apply.

Figure G.2 shows the percentage of WoF inspections in which the vehicle failed and the mean number of faults identified per WoF inspection by the age of the vehicle. A failure occurs when at least one fault (defect) is identified. This shows that the failure rate generally increases with increasing vehicle age.

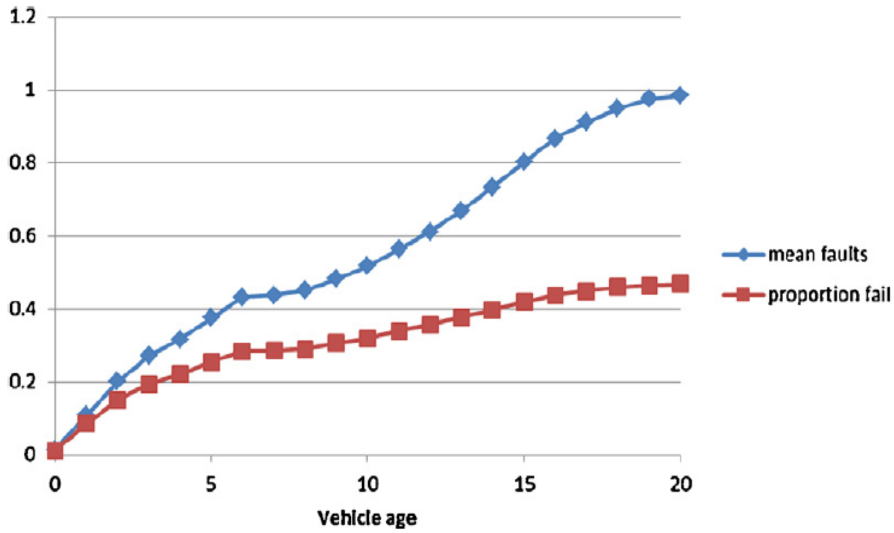


Figure G.2. Percentage of WoF inspections where the vehicle failed and mean number of faults found by the age of the vehicle

Figure G.3 shows the mean number of faults identified per WoF inspection regarding the four most common fault types: brakes, tires, steering/suspension, and lights. Similar to the pattern shown in Figure G.2, all fault types increase as the vehicle age increases. They show a marked flattening of the curve after the vehicle reaches six years old, when the vehicles are inspected at six-month intervals.

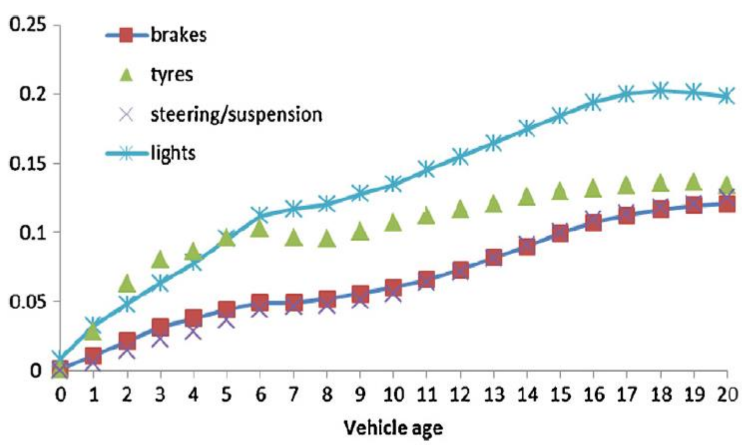


Figure G.3. Mean number of faults identified per WoF inspection by the age of the vehicle and class of fault identified

Figure G.4 shows how the mean number of faults varies based on the age of the owner. The greatest number of faults is found for younger owners: those aged less than 30. Owners aged over 60 have the lowest average rate of faults, followed by owners aged between 30 and 59.

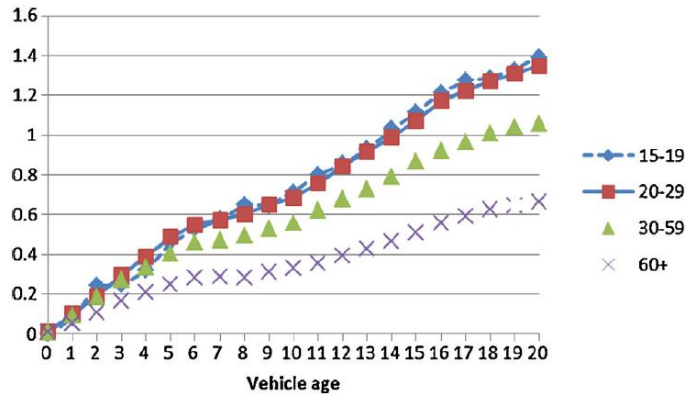


Figure G.4. Mean number of faults identified per WoF inspection by the age of the vehicle and age group of owner

A logistic regression model was used to analyze the merged crash and licensing data. As Figure G.5 depicts, the crash risk increases as the vehicle age increases. According to Keall and Newstead (2013), the crash rate was estimated to fall by 8% with 95% confidence interval 0.4–15% due to the switch from annual to six-month inspections starting at the vehicle age 7.

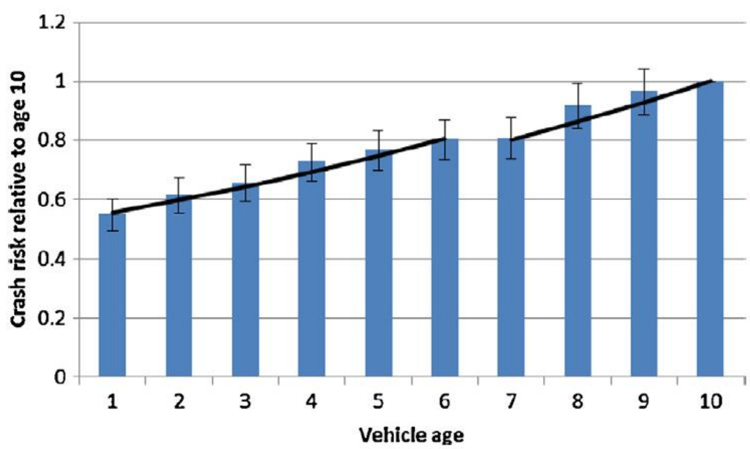


Figure G.5. Crash risk of vehicles by age of vehicle relative to vehicles aged 10

- <u>*Vlahos, Nicholas J., Samuel T. Lawton, Anurag K. Komanduri, Yasasvi D. Popuri, and Danena L. Gaines, 2009. Pennsylvania's Vehicle Safety Inspection Program Effectiveness Study (070609) Summary of Findings. The Pennsylvania Department of Transportation. Report No. PA-2009-004-070609. Prepared by Cambridge Systematics.*</u>

Vlahos et al. (2009) conducted a study to consider the effectiveness of vehicle safety inspections on the number of fatal crashes, and the benefits of the program compared to the cost of inspections to the owners of Pennsylvania-registered vehicles. They developed and implemented a statistical analysis based on crash data from the Fatality Analysis Reporting System (FARS), control data from a variety of national sources, and characteristics of existing programs nationwide. They also conducted telephone interviews with representatives from New York Department of Motor Vehicles, Vermont Department of Motor Vehicles, Missouri State Highway Patrol, and Ohio DPS.

They used three different classes of model formulations and the results were clear and consistent: states with vehicle safety inspection programs have significantly fewer fatal crashes than states without programs. The benefits of the program as derived from all three models exceed the user costs of the program.

Based on the model results, Pennsylvania can be expected to have between 115 and 169 fewer fatal crashes each year, corresponding to between 127 and 187 fewer fatalities each year, than it would if it did not have a vehicle safety inspection program. They concluded that their results clearly demonstrated that the vehicle safety inspection program in Pennsylvania is effective and saves lives.

- *Christensen, P. and Elvik, R., 2007. Effects on accidents of periodic motor vehicle inspection in Norway. Accident Analysis & Prevention, 39(1), pp.47-52.*

Christensen and Elvik (2007) evaluated the effects on accidents of periodic inspections of cars, excluding trucks and buses. They applied negative binomial regression models to fit the data on 1998–2002 accidents and inspections created by merging data files provided by a major insurance company and by the Norway Public Roads Administration. Their findings suggest that technical defects in cars are associated with a small but statistically significant increase in accident rate. Inspections were able to strongly reduce the number of technical defects in cars. However, no effect of inspections on accident rate were found. It is suggested that car owners adapt driving behavior to the technical condition of the car and that the effect attributed to technical defects before inspection may in part be the result of a tendency for owners who are less concerned about safety to neglect the technical condition of their cars.

- *Poitras, M. and Sutter, D., 2002. Policy ineffectiveness or offsetting behavior? An analysis of vehicle safety inspections. Southern Economic Journal, pp.922-934.*

Poitras and Sutter (2002) developed an econometric model to examine the effect of inspection on registrations of old vehicles using panel observations of the 48 contiguous states and the District of Columbia. The panel data was obtained from Automotive Industries and consist of 733 observations for the years 1953–1967. They found that inspection has no significant impact on old cars or repair industry revenue, which implies that inspection does not improve the mechanical condition of vehicles. They also distinguished between policy ineffectiveness and Peltzman-type offsetting behavior as sources of inspection failure. Poitras and Sutter (2002) suggest that periodic vehicle inspection is a poor instrument for achieving policy goals.

- *Sutter, D. and Poitras, M., 2002. The political economy of automobile safety inspections. Public Choice, 113(3-4), pp.367-387.*

Sutter and Poitras (2002) developed econometric models to examine the incidence of inspection across states, and determinants of regulated inspection fee. They used 1981 to 1983 panel data of 50 U.S. states. Their results indicate no significant correlation between predicted roadway casualties and inspection requirements, and their hypothesis of misallocation of inspection resources cannot be rejected.

- *Rechnitzer, G., Haworth, N. and Kowadlo, N., 2000. The effect of vehicle roadworthiness on crash incidence and severity (No. 164). Monash University, Accident Research Center.*

Rechnitzer et al. (2000) conducted a comprehensive literature review and data analysis, involving Victorian Case-Control Study of Fatal Single-Vehicle Crashes, Victorian Case-Control Study of Motorcycle Crashes, and the Coroner's database (Victoria, Australia). They found that there was significant variation in study findings regarding the role of vehicle defects in crash causation and the effectiveness of Periodic Motor Vehicle Inspections programs in reducing defects and crashes. Studies of crashed vehicles have shown that defects contribute directly or substantially from around 3% to 19%, with the more robust studies indicating at least 6%. Common defects identified relate to brakes and tires, which could be detected during an inspection. In addition, the effect of inspection programs on accident rates as assessed by the studies varied significantly, from no effect to decreasing the accident rate by up to 16%. The authors noted that few studies examined the effect of inspection programs on the incidence of defects: for example, NHTSA (1989) found that an inspection program was associated with a 2.5% reduction; and in Sweden, it was found that 7–8% of vehicles with serious defects were replaced after the introduction of an inspection program (Asander, 1993). The authors also noted that some studies suggest that periodic roadworthiness tests could reduce the number of crashes caused by vehicle defects by about 50% (for example, a study conducted by Romp and Seul in 1985).

Rechnitzer et al. concluded that vehicle age was found to be an important factor. In Australia, it was found that the likelihood of being involved in a fatal single-vehicle crash was 2.5 times greater for a driver of a pre-1978 vehicle than a newer vehicle.

- *Merrell, D., Poitras, M. and Sutter, D., 1999. The effectiveness of vehicle safety inspections: An analysis using panel data. Southern Economic Journal, pp.571-583.*

Merrell et al. (1999) examined the effectiveness of state automobile safety inspections from a panel of the 50 states for the years 1981–1993. They estimated a fixed effects regression model that incorporated state-specific shifts in casualty rates. They found no evidence that inspections significantly reduce fatality or injury rates. They also provided evidence on the effects of speed limits, seat belts, and Peltzman's offsetting behavior hypothesis. The authors noted several potential reasons that account for the failure of safety inspections to reduce accidents. First, inspections may induce an offsetting increase in driving intensity. Second, drivers have a strong incentive to perform maintenance to provide for their own safety. Third, inspections can at best prevent only a small fraction of accidents since most accidents do not involve mechanical failure. Additionally, inspectors can fail, intentionally or unintentionally, to report vehicle defects. Inspectors may fail to report defects to minimize customer hassle and increase the number of inspections performed; they noted, for example, that Hemenway (1989) found evidence that motorists tend to patronize repair shops with a low failure rate on inspections.

- *Holdstock, J., Zalinger, D. and Hagarty, D., 1994. Review of a mandatory vehicle inspection program: project report.*

The British Columbia Government ended a periodic mandatory private-vehicle inspection program in 1983. This study was initiated to assess whether a cost-beneficial program exists or could be developed that would improve highway safety through the reduction of accidents, particularly those with fatalities or injuries. The authors analyzed the statistics of accidents caused by defective or unsafe motor vehicles in B.C. or other jurisdictions; assessed the impact of vehicle-inspection programs on vehicle fitness and road safety; and conducted a survey of the public's opinion on the importance of such a program. They also conducted regression analysis using 1990–1991 data for 50 states, District of Columbia, and 10 Canadian provinces. The results indicated that it was unable to establish a statistically significant effect of vehicle inspection program on fatalities or injury rates.

- *Asander, S., 1993. Vehicle safety inspection systems. In Wheels '92: Conference and Workshop; Proceedings (p. 63). Institution of Engineers, Australia.*

Asander (1993) summarized statistical reports since the introduction of inspection program in Sweden in 1965, which are published by AB Svensk Bilprovning, the Swedish motor-vehicle inspection company. The statistics showed that that introduction of a compulsory inspection program in Sweden has resulted in a vehicle fleet with fewer defects than before its introduction. The first change made after the introduction of compulsory inspection program is to reduce the most serious defects in the vehicle fleet. In 1965, 7–8% of vehicles were replaced due to serious defects. Asander (1993) suggested two reasons for this: one is that car owners were more aware of the condition of their own vehicles and chose to replace them in order to pass inspections. The other is that the owners felt that it was not worthwhile to repair the defects identified at an inspection, and scrapped the vehicles.

In addition, police reported accidents with personal injury decreased by 16% between 1964 and 1966, the years immediately preceding and following the introduction of compulsory inspection program.

- *Fosser, S., 1992. An experimental evaluation of the effects of periodic motor vehicle inspection on accident rates. Accident Analysis & Prevention, 24(6), pp.599-612.*

Fosser (1992) conducted an experimental evaluation of the effects of periodic motor vehicle inspection on accident rates. In the research, 204,000 cars were randomly assigned to three different experimental conditions. First, 46,000 vehicles were inspected annually during a period of three years (inspected in 1986, 1987, and 1988); 46,000 cars were inspected once during those three years (inspected in 1986 only); and 112,000 cars were not inspected (control group). The number of accidents was recorded for a period of four years. The technical condition of inspected vehicles improved compared to those not inspected. However, no differences in accident rates were found between the groups. It is concluded that periodic motor vehicle inspection has no preventive effect on the technical condition of cars in a system where roadside inspections also exist. The authors also caution that there are a number of factors that should be considered in the interpretation of the results. In Norway, there is a high level of random roadside inspection (about 20% of vehicles per year) and this might be enough incentive for owners to prevent and remedy defects in their vehicles such that periodic inspections have no additional effect.

Finally, the age of the cars in this study was deliberately restricted to between approximately 7 and 11 years, so that the cars would be old enough to have developed technical defects, but not too old as to be likely to be scrapped during the experiment. It may be that periodic inspections have a beneficial effect for vehicles older than 11 years.

- *NHTSA (1989). Study of the effectiveness of state motor vehicle inspection programs: Final report. Report of the US Department of Transportation: USA*

Three series of analyses were conducted in this report to determine whether inspection programs were reducing the crash rates of passenger cars. The crash rate proportion of old to new vehicles in each state was analyzed. The results for states with and without inspection programs were compared. At the time of this study, 22 states had inspection program while 29 did not, noting the fact that 19 out of the 29 states without inspection program conduct random inspections of PVs. In addition, considerable variation exists in the equipment items inspected and the procedures, rules, and regulations for inspections within the 22 states with inspection program.

Three main data sources used in this study through three types of analysis included the Fatal Accident Research System (FARS); state accident data obtained from each state (since not all the states maintain the crash database, data from four states with inspection programs and six states without were used); and component failure data obtained from the Crash Avoidance Research Data files (CARDfile) coded by the police officers.

- **Series One Analysis**

  The researchers made two comparisons in the series one analysis. In both comparisons, the crash rates of vehicles with different ages were compared between states with inspection program and states without inspection program.

  The first comparison used FARS and state accident data (vehicles one to three years old), over a single 12-month crash period between July 1, 1985, and June 30, 1986. The researchers found that there is no effect of inspection programs on the fatal crash involvement rate according to the FARS data. Based on the state accident data, the overall accident rate was always higher in states without inspection programs, regardless of the age of the vehicle.

  The second comparison used FARS data to compare crash rates of 1975 model year cars over the years 1976 to 1986. They found that there was no difference between states with and without inspection programs for cases in which older cars have crashes.

- **Series Two Analysis**

  NHTSA conducted a second series analysis using CARDfile from 1984 to 1986 for four states: Maryland, Washington, Pennsylvania, and Texas. Maryland and Washington do not have inspection programs, while Pennsylvania and Texas do. Almost 600,000 PVs were examined from Maryland and Washington, and over 1.5 million PVs were examined from Pennsylvania and Texas. Only passenger cars 10 years or younger were included in the analysis. Based on the CARDfile, the proportion of crashed vehicles with a component failure identified as a contributing factor was found to be significantly greater in states without inspection programs for cars of all ages. This difference ranged from less than 0.25% to a 2.5% difference, depending on the age of the car. Older cars experienced a greater difference.

In the follow-up analysis, vehicle component failures reported by police in fatal crashes were analyzed using FARS data from 1985 to 1987. It was found that the proportion of vehicles involved in a fatal crash with defects identified as contributing factors is consistently higher in states without inspection programs than states that are performing inspections.

The researchers found that the fact the proportion of older crashed vehicles with a component failure identified as a contributing factor was greater in states without inspection programs, which supports the notion that the difference is due to inspections.

- **Series Three Analysis**

In the series three analysis, the researchers used CARDfile data to conduct analysis by defect type. They found that tire failures were significantly more common (up to 2.5%) in states without inspection programs for almost all vehicle ages, which possibly indicates that the inspection program is effective.

- *White, W.T., 1986. Does periodic vehicle inspection prevent accidents? Accident Analysis & Prevention, 18(1), pp.51-62.*

New Zealand has a mandatory biannual vehicle safety inspection program. In this study, White examined the accident rate of New Zealand vehicles in relation to the time since their most recent inspection. He obtained over 21,000 written inspection records from inspection stations and Traffic Accident Report data from the New Zealand Ministry of Transport. A 13-month period was chosen for analysis as this was just over twice the official inter-inspection period. The results indicated that the probability of accident involvement increases with time since last inspection. More specifically, the accident rates were lowest one week after inspection, and then increased by 10–15% over the next six months until a peak one week before the next inspection. The author concluded that mandatory safety inspection has an immediate safety benefit that decreases over time. The study suggests that vehicle defects do contribute to accidents, but that periodic vehicle inspections may not be the best method to maintain roadworthiness. White also noted that the data was not of ideal quality since it was obtained from one area of New Zealand and could not be representative of the whole country.

- *Rompe, K. and Seul, E., 1985. Advantages and disadvantages of conducting roadworthiness tests to monitor the mechanical condition for private cars, the impact of such tests on road safety, environmental protection and the renewal of the vehicle fleet and the scope for introducing roadworthiness testing throughout the European community. Final report commissioned by the Directorate-General for Transport. VII/G-2 of the Commission of the European Communities. Drawn up by the TUV Rheinland.*

This analysis reviewed U.S. studies on the effectiveness of periodic vehicle inspection and found that periodic inspection could reduce the number of accidents caused by vehicle defects by about 50%. They also found that inspection programs might also affect and reduce the crashes by improving the drivers’ knowledge and understanding of the need for regular maintenance, safety issues, and the condition of their own cars.

- *Berg, G., Danielsson, S. and Junghard, O., 1984. Trafiksäkerhet och periodisk fordonskontroll (Traffic safety and periodic vehicle inspections).*

Sweden introduced mandatory annual inspection of all cars in 1966. This analysis performed a time-series analysis covering the years from 1955 to 1981, both before and after the safety inspection program is introduced. They found that the number of cars involved in police-reported accidents decreased by 14% following the introduction of annual inspections. The number of injury accidents declined by 15%. The number of injured persons declined by 9% and the number of property-damage-only accidents decreased by 3%.

- *Loeb, P.D. and Gilad, B., 1984. The efficacy and cost-effectiveness of vehicle inspection: a state specific analysis using time series data. Journal of Transport Economics and Policy, pp.145-164.*

This study employed a time-series analysis of the efficacy of inspection in reducing fatalities, injuries, and accidents. They used New Jersey data and developed an econometric model to evaluate inspection while accounting for various socio-economic factors, as well as technology- and driving-related variables. The study analyzed time-series data for the years 1929 to 1979, which includes data from both before and after the introduction of compulsory inspection program to New Jersey in 1938. The results of the econometric study are then used to evaluate a partial benefit/cost analysis of the system of motor vehicle inspection. Regression analyses were carried out separately for accident rates, fatality rates, and injury rates. The results indicate that the presence of the inspection program statistically significantly reduced the number of highway fatalities (by over 300 per year) and accidents (by almost 38,000 per year) in New Jersey. No significant effect of inspection program on reducing injuries was found. They suggested two reasons why there are significant decrease in fatalities and accidents but not injuries: one is that inspections may detect major safety defects but not minor ones. The other is that inspection may play a role in changing the attitudes of drivers such that they fix major safety defects.

- *Van Matre, J.G. and Overstreet Jr, G.A., 1982. Motor vehicle inspection and accident mortality: A reexamination. Journal of Risk and Insurance, pp.423-435.*

This study applied a multiple regression mode to study the relationship of motor vehicle inspections and accident mortality. Three inspection schemes are explicitly considered: periodic inspection, random inspection, and no inspection. They used very detailed data published by the American Statistical Association; U.S. Bureau of the Census; U.S. Department of Health, Education and Welfare; U.S. Department of Transportation; Federal Highway Administration; and NHTSA. The fatality rate model indicates that both random and periodic schemes are effective in reducing fatality rates when compared to states with no inspection. The fatality rate per 100,000 inhabitants was about 10% lower in states with periodic motor vehicle inspection than in other states. They also pointed that random inspection appears to be more effective than periodic inspection.

- *National Highway Traffic Safety Administration (NHTSA), United States Department of Transportation, (1980): The Effects of Automobile Inspections on Accident Rates. HJS-805-401.*

In this experimental study, vehicles were grouped into two samples: one consisted of vehicles that underwent (voluntary) inspection, and the other of non-inspected vehicles. The accident rate of vehicles was observed over a 12-month period. The two samples were matched for make, model, and year of manufacture. The results showed a statistically significant difference in accident rates: the inspected vehicles had fewer accidents than the non-inspected ones. The results also held when accident rates were adjusted for differences in sex and age. However, since non-random sampling procedure used in the study may have biased the selection of drivers, these results should be interpreted with caution.

- *Crain, W.M., 1980. Vehicle safety inspection systems. How effective? American Enterprise Institute for Public Policy Research: Washington DC.*

This analysis used 1974 data (which contains fatality rate, injury rate, and accident rate) and certain socio-economic variables (e.g., population density, median family income, fuel consumption, etc.). Crain compared accident rates in states with periodic motor vehicle inspection to states without the program. Crain did not find any statistically significant differences in fatality rates between states with periodic motor vehicle inspection and states without it. There was a non-significant tendency toward higher fatality rates in states with periodic motor vehicle inspection. In addition, Crain noted that there was no statistically significant difference in accident rates between states with biannual inspections and states with annual inspections. He concluded that the vehicle inspection programs do not have the expected effect of reducing accident rates, and that more frequent inspections do not tend to reduce accident rates. Crain also pointed out that random vehicle inspections were found to be those with the lowest accident rates. Crain (1980) suggested two possible reasons why inspection programs may have failed to reduce crash rates in his study. One is that additional resources devoted to vehicle maintenance because of periodic inspection may not improve the inherent safety characteristics of the vehicle; the other is that periodic vehicle safety inspection do make the vehicle safer, but this potential for improved safety is dissipated by adjustments in driver behavior.

- *Schroer, B.J. and Peyton, W.F., 1979. The effects of automobile inspections on accident rates. Accident Analysis & Prevention, 11(1), pp.61-68.*

This study compared the accident rates of vehicles that participated in the Alabama Motor Vehicle Diagnostic Inspection Demonstration Program (similar to periodic motor vehicle inspection because Alabama does not have a mandatory inspection program) with vehicles that did not actively participate.

The authors used data from the Auto Check inspection files, the Madison County motor vehicle registration files, and the Alabama DPS accident files. A sample of cars (1968 to 1973 model years) from urban areas was selected that had a first periodic inspection between April 1975 and December 1976. The Auto Check sample comprised almost 8,500 vehicles and the non-Auto Check sample comprised over 30,000 vehicles.

They found that the accident rate of inspected vehicles represents was 9.1% lower than the rate for uninspected vehicles in Huntsville. Moreover, the drivers who returned for subsequent periodic inspections experienced a 21% improvement over the accident rate of drivers in the uninspected vehicle group. The study also indicated that the monthly accident rate of the responsive participants who returned for subsequent periodic inspections did not significantly increase over eighteen months, while the monthly accident rate of unresponsive participants increased to the level of uninspected vehicles.

In addition, the accident rate of inspected vehicles decreased at least 5.3% after inspection. The inspection reject rates for the brake, steering suspension, and wheel alignment systems for Auto Check vehicles involved in accidents were compared to the reject rates for the non-accident vehicles. Vehicles involved in accidents were in significantly worse mechanical condition on the average than those not involved in accidents. The results suggest that poor mechanical condition is a significant factor in motor vehicle accidents and annual inspections are a desirable and effective means of reducing accident rates. However, the influence of self-selection on the results cannot be ruled out, as the subjects for the study were all volunteers.

- *United States Department of Transportation, National Highway Traffic Safety Administration (NHTSA): Costs and Benefits of Motor Vehicle Inspection, 1975.*

In the report published by NHTSA (1975), the states of Nebraska and Alaska conducted a descriptive comparison of accident rates before and after the introduction of inspection program, respectively. NHTSA compared the percentages before and after the introduction of the inspection program of all fatal accidents, where vehicle defects played a causative role. Both states saw a decline in these percentages, which indicates that their inspection programs had a positive impact on reducing the fatal accident rates.

- *Little, J.W., 1971. Uncertainties in evaluating periodic motor vehicle inspection by death rates. Accident Analysis & Prevention. 2, 301-313.*

This study conducted a controlled before-and-after study to examine the effect of inspection program on fatality rates, where six U.S. states formed the experimental group and various other states formed control groups. The data are obtained from the National Safety Council, which consists of death rates and numbers of deaths. There was some variation in results within each group studied. For example, some test states experienced an increase (5%) in death rates following the introduction of inspection program, and some experienced a decrease in death rates over the same period of time. There was no statistical difference in crash rates between inspecting and non-inspecting control groups over time. There was no statistically significant difference in the increase in death rates between test states and the nation as a whole. Compared to a simple before-and-after study or a simple with-and-without comparison, the use of control groups is an advantage of this study. However, the differences found between test and control states were not necessarily caused by the introduction of periodic motor vehicle inspection alone. Little noted that “the most reasonable conclusion may be that something more fundamental than inspection is at work in producing and changing death rates.”

- *Fuchs, V.R. and Leveson, I., 1967. Motor accident mortality and compulsory inspection of vehicles. Journal of the American Medical Association, 201(9), pp.657-661.*

This analytical study employed multivariate statistics to examine the relationship between motor accident mortality and compulsory vehicle inspection. They conducted the study by regressing age-standardized mortality ratios on inspection and other variables across states. Their model used 1960 data and allowed for the effect of several variables simultaneously, and thus more clearly isolated the effect of inspection. They considered 11 independent variables; however, in their linear unweighted model, only three were significant: gas consumption, population density, and other accident mortality. When the inspection variable was the only independent variable, they found a significant negative effect on accident death rates. When more regressors were added to the model, the efficacy of motor vehicle inspection in reducing mortality rates was not statistically significant. They concluded that inspection is negatively related to mortality, but the net effect of inspection is very small and does not generally differ from zero at high levels of statistical significance.

- *Buxbaum, R.C. and Colton, T., 1966. Relationship of motor vehicle inspection to accident mortality. Journal of the American Medical Association, 197(1), pp.31-36.*

This study used 1960 data to examine the role of mechanical failure in automobile accidents by comparing motor vehicle mortality among men aged 45 to 54. They compared the statistics between the states that do and do not require motor vehicle inspection. The results indicated that inspection is associated with lower mortality, and this association prevails under varying economic, geographic, and demographic conditions.

Appendix H. Stakeholder Interviews

In order to obtain more insightful information regarding the Inspection Program the CTR team interviewed nine stakeholders who are experienced industry professionals, including inspectors, car dealers, and inspection station owners. Most of the interviews were conducted through teleconference. Their experiences are valuable to this study. The key points recorded and are summarized below.

H.1. Interview with Laird Doran and Mike Sullivan

Laird Doran is the Vice President, Government Relations and Senior Counsel of The Friedkin Group/Gulf States Toyota. Gulf States Toyota is the world's second-largest distributors of Toyota cars and parts. Mike Sullivan is the Director of Governmental and Public Affairs of Group 1 Automotive. Group 1 Automotive has the largest fleet in volume participating in the Inspection Program in Texas. The teleconference was conducted at 3:00 p.m. on April 25, 2018.

Below are the key points made during the interview:

- Gulf States Toyota performs mandated inspections on new vehicles to ensure the vehicle is in the safest condition possible; approximately 180,000 inspections are performed annually.
- Dealerships always check if there is recall on the vehicle.
- Approximately 20% of vehicles that come to the Group 1 Automotive dealership for inspection have an open recall.
- The CTR study team should compare the recall completion rates between states with and without inspection programs.
- Somebody has to physically inspect the vehicle no matter how complicated the vehicle technology is.

When asked about potential improvements to the Inspection Program to tackle fatality-causing vehicle fires, the following was suggested:

- Texas should enhance the Inspection Program by incorporating an open recall check.

H.2. Interview with Shelly Richardson

Shelly Richardson is President of HAF, Inc., and co-owner with her husband of an inspection station in the City of Houston. During the initial interview, CTR learned that the City of Houston contracted with HAF and one other station to perform inspections from 2011 to 2016 of taxi cabs and limousines operating in Houston. The taxi and limousine inspection was separate from and in addition to the state motor vehicle inspection also required for these vehicles. The CTR team traveled to Houston on July 20, 2018, to pick up the inspection records, on loan, from the station for further analysis; see Chapter 6 for the results.

The teleconference was conducted at 9:00 a.m. on June 5, 2018. Below are the key points made during the interview:

- The emissions and safety inspection equipment (made by World Wide, Inc.) can print out vehicle safety recall information; VIC safety-only units provided by TxDIR cannot print out vehicle safety recall information.
- Ms. Richardson has found many defects on vehicles with salvaged titles and almost all vehicles inspected for the City of Houston (she does not believe the state should allow salvaged titles).
- Since 2007, Richardson's station has performed inspections of taxi and limousines—they were found to have many safety issues.
- Ms. Richardson's station has seen too many vehicles with serious defects; she cannot imagine [how many more] without the Inspection Program.
- Ms. Richardson is firm in her belief that the Texas needs the Inspection Program and that it should not be eliminated.

H.3. Interview with Grady McGoldrick

Grady McGoldrick has 18 years of experience as an inspection operator. The teleconference was conducted at 9:00 a.m. on June 6, 2018. Below are the key points made during the interview:

- Mr. McGoldrick's station inspects more than 100 vehicles per week. The number is larger during the first week of each month.
- DPS officials check the inspection stations about once a month.
- Many people do not realize the importance of proper state inspections, and how vital it is for everyone's safety. Under the current inspection program, people can assume that other drivers on the roadway have had a proper vehicle inspection at least within the last 12 months, and are driving with safe tires and brakes. Without the state inspection program, traveling on Texas roads and highways will be much more dangerous for the public.
- In the 18 years he has been inspecting vehicles, a common problem with front wheel drive vehicles is steel belt showing on the back side of the tire tread—although the visible outside tread will look perfectly fine. Mr. McGoldrick commented, "I don't know how many times I have been thanked by customers for catching this dangerous situation before it could have resulted in a blow-out and possibly loss of control of their vehicle."
- Mr. McGoldrick worries about who would bear the responsibility of conducting vehicle safety checks if there is no state inspection program. He thinks that expecting state troopers to pull cars over when they think there is a problem with the car is not a solution. He says

it is very difficult to know that a car is not safe from pure observation and that Texas can't solely rely on state troopers to conduct safety checks. He notes that it would be impossible for state troopers to know the condition of tires, brakes, exhaust, and other inspection items while sitting on the side of the road. Inspections need to be done in a location safe for both trooper and driver. For example, 25 feet of roadway is required for conducting a brake test, which would be neither safe nor sensible if taking place along the roadway with traffic flowing past.

When Mr. McGoldrick was asked about his thoughts on potential improvements to the inspection program to tackle fatality-causing vehicle fires, he mentioned:

- If an inspector smells a gas or oil leak, the car should fail the inspection.
- There is no way to know if the vehicle has a salvage title or not during the inspection.
- Texas needs the Inspection Program and the program should not be eliminated.

H.4. Interview with James Loftin

James Loftin worked for NASA for 40 years prior to operating an inspection station in an emissions and safety testing county for four years. The teleconference was conducted at 10:00 a.m. on June 6, 2018. Below are the key points made during the interview:

- TxDPS audits Mr. Loftin's station every one or two weeks.
- Mr. Loftin uses a stationary laptop, ESP System 1. The ESP System 1 provides statistics on how many vehicles are inspected and how many failed, as well as the number of the vehicles that pass the inspection after repairs.
- TxDPS sends decoy defective vehicles to stations. The decoy driver requests an inspection and if the inspector does not find the defect during the inspection, the TxDPS auditor might issue a citation to the inspector and/or the station. Depending on historical conduct of the station, the station may lose its station license for a specified period of time.
- Mr. Loftin expressed concerns about the placement of the battery in some newer vehicles. Some cars place the battery under the rear seat or in the trunk, which are typically considered difficult-to-reach areas. Mr. Loftin has some concerns about battery acid leaks or other problems related to the battery that are currently not inspected during a safety inspection.
- Mr. Loftin tells his customers whether their vehicle has an open recall (if there is an open recall, he tells the customer what the recall is about).
- Mr. Loftin thinks every station should be able to print a list of open recalls. Currently, only stations that are in emissions testing counties have equipment that can print out a list of open recalls for a vehicle. Stations in safety-only counties that use the VIC unit cannot print out vehicle recall notices.
- Mr. Loftin attended a two-day school for station operators organized by TxDPS.

- Texas needs and should not eliminate the Inspection Program.

H.5. Interview with Terry Meyer

Terry Meyer owned ten inspection stations for five years. He now owns five inspection stations. He has maintained a database for each station and each vehicle inspected, including whether the vehicle failed the inspection the first time, the types of repairs (costs) needed, and whether the vehicle passed the final inspection. The teleconference was conducted at 12:00 p.m. on June 6, 2018. Below are the key points made during the interview:

- Mr. Meyer's stations inspect about 10,000 vehicles a month in recent years.
- Mr. Meyer named the three most common inspection station equipment providers:
    1. Tabis Unit provided by TxDPS – Meyer's station uses this
    2. ESP System 1 – combo of safety and emission, provides recall information
    3. World Wide – safety and emission
- DPS inspects the inspection stations by sending an auditor and/or decoy vehicle to identify compliance issues.
- DPS auditors are always plain-clothed, and are typically the same person from year to year.
- Mr. Meyer mentioned that inspectors that make procedural mistakes receive either written or verbal warnings.
- Inspection reports always provide open recall information to customers in emission counties, but not safety-only counties.
- Texas needs and should not eliminate the Inspection Program.

When Mr. Meyer was asked to suggest improvements to the safety inspection program, he mentioned the following:

- Tell the customers about the recalls—currently inspectors do not need to provide recall information to the customers. Recall information should appear on all inspection reports.
- The inspection should check for massive oil leaks.
- The inspection should check wire harnesses.
- The inspection should check the amount of water in the braking system—this is mandatory in European countries.
- The inspection should check tires; as no one is considering what the tires look like inside and rotting tires can pose a safety hazard.

Mr. Meyer suggested a few potential causes of vehicle fires for consideration when suggesting enhancements to the safety inspection check:

- If a vehicle is in a crash, the fuel pump might still be pumping fuel even after the engine has stopped; this could result in a fire.

- EPA promotes soy-based plastics for electrical wiring insulation, which he believes are more susceptible to fire.
- Batteries located under the rear seat.

H.6. Interview with James Bell

James Bell has been in the vehicle inspection business for 50 years and has extensive experience with safety inspections. The teleconference was conducted at 2:00 p.m. on June 6, 2018. Below are the key points made during the interview:

- A TxDPS auditor comes to the station at least once a month.
- Stations can issue coupons to reduce the inspection fee. An inspection station can charge less than the state-allowed fee of $7.00, but not more than the allowable amount.
- Mr. Bell suggested the following improvements to the safety inspection program:
    a. Wire inspection: wire failure (due to rubber aging or other natural deterioration) could be listed as one inspection criterion
    b. Tire rot check: Tires rot on the inside because of age. Keeping a set of tires for 10 years is too long.
    c. Tread depth gauge to check across the entire width of the tire and not just in the center
    d. A more comprehensive inspection of brakes would improve the inspection program.
- Police officers used to remove inspection stickers if a car was damaged in a crash, and would require the owner to conduct an inspection within a given time period. Now that registration and inspection are covered with only one sticker, it may no longer be possible for an officer to ensure a crashed car is re-inspected after a crash.
- The cost of the Inspection Program to TxDPS includes the auditor and the decoy vehicles used to monitor stations.
- Mr. Bell will fail the inspection if he sees any age cracks in the tire.
- Mr. Bell's inspection testing equipment gives him recall information, and he provides the recall information to the owners.
- Some businesses perceive that business volume will drop if they do inspections right.
- Mr. Bell believes (automobile) manufacturers should bear the responsibility of recall issues, including contacting the owners.
- In emission counties, station owners pay for the inspection equipment.
- Texas needs and should not eliminate the Inspection Program.

H.7. Interview with Abel Porras

Abel Porras is the co-chair of the Texas State Inspection Association. He visited the Center for Transportation Research on June 13, 2018. The CTR team met with him in person and conducted the interview at 9:00 a.m. Below are the key points made during the interview:

- The minimum and maximum size of mud flaps (splash guards) should be required and added to the safety inspection.
- The Two Steps, One Sticker program is more efficient, and eliminates the need for inspection stations to buy stickers in advance.
- Vehicle safety inspection is not trivial—it is a serious issue. Once, Mr. Porras inspected a vehicle and pointed out a defect that was fixed, and the owner came back to his shop to thank Mr. Porras for saving his life.
- Many companies (such as large tire companies, for example) hold seminars to emphasize the importance of proper inspection of wear-and-tear items, therefore encouraging inspectors to take pride in their work. While being an inspector is not the most high-paying job, inspectors know that their job is important and understand that the outcome of their efforts is saving lives.
- Laws protect against corruption.
- When considering adding inspection items to the list, officials should pay careful attention to making sure the inspection does not over-inspect vehicles by inspecting more unnecessary items, which could increase the likelihood of false failures.
- It would be much better to inspect tire tread depth across the width instead of the middle point only.
- The relationship between inspectors and customers is important because the inspectors make recommendations to the customers about repairs.
- Many first-time failures that are not recorded; therefore, the statistics contained within the TxDPS database do not show a complete picture.
- Though the inspection process has some flaws and shortcomings, it is much better than having nothing.

H.8. Interview with Ed Martin

Ed Martin is the director of Safety & Emission Inspection, Take 5 Oil Change LLC. Mr. Martin is also the Chair of the Texas Vehicle Inspection Association, an advocacy group that represents all vehicle inspection stations. He has worked in and around the automotive service industry segment since the late 1970s. The teleconference was conducted at 10:30 a.m. on June 13, 2018. Below are the key points made during the interview:

- Vehicle recall information is very important and can be obtained during an inspection.

- Moving away from two stickers to one sticker is an improvement. The inspection/registration process is more efficient and effective.
- Mr. Martin has met with Dr. Matthews (who performed a safety inspection study for Pennsylvania) in person. Their studies for Pennsylvania indicate that safety inspections are effective in reducing crashes.
- Mr. Martin does not think that a $7 safety inspection fee costs that much relative to the services rendered.
- Inspection machines have the capability of capturing first-time failures. There is an option that indicates “passed the inspection after repair.”
- DPS offers a two-day training for inspectors. No repeat training is required.
- Some inspection criteria were changed around four years ago.
- The Inspection Program is needed and should not be eliminated.

Appendix I. Workshop

I.1. Workshop Agenda

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

Agenda

Costs and Benefits of the Texas Motor Vehicle Safety Inspection Program for passenger vehicles

June 26, 2018

9AM – 3PM

University of Texas at Austin – Pickle Research Campus
Commons Learning Center – Balcones Meeting Room

9AM – 11AM

1.	**Welcome and brief introductions**	Mike Murphy (CTR)
2.	**Plenary Session Presentations**	
a.	Overview – Study Scope and Objectives	Mike Murphy (CTR)
b.	'Big Data' Analysis – preliminary results	Nan Jiang (CTR)
c.	MVSIP costs	Darren Hazlett (CTR)
d.	Incorporating recalls in MVSIP	Michael St. Denis (Revecorp)
e.	Online surveys – preliminary results	Mike Murphy (CTR)

Buffet Lunch 11AM – 12PM

12PM – 2PM

3. Breakout Sessions

a. BEVO Room – Workshop attendees
b. Stadium Room – Workshop attendees
c. Balcones Room – WebEx

2PM – 3PM

4. Reconvene – Balcones Room Breakout Session Key Takeaways

5. Adjourn

I.2. Workshop Plenary Session Summary

Dr. Mike Murphy, Dr. Nan Jiang, and Darren Hazlett presented their preliminary findings from this study.

Dr. Michael St. Denis, President of Revecorp, presented information about increasing vehicle recall completion rates by including recall information in the vehicle safety inspection report. Revecorp is currently assisting several states with increasing recall program effectiveness.

Dr. St. Denis pointed out that vehicle recalls are more common than ever. The Takata "Alpha" airbag recall, the biggest in history, is attempting to remedy defective airbags that have a 50% chance of causing death or serious injury if activated. Yet, in general only 65% of vehicle owners perform recall repairs even though repairs are free of charge.

He presented results on a case study conducted with the District of Columbia and Vermont Department of Motor Vehicles on incorporating recall information on vehicle safety inspection reports. This case study showed a 400% increase in recall remedy after printing recall information on the vehicle inspection report. Dr. St. Denis estimated $242 million of potential Texas revenue inflow to Texas car dealerships that service recalls as a benefit of the recall application. The State of Texas would benefit from taxes resulting from repairs and/or replacements of defective parts.

It was noted that in Texas safety and emissions counties do have inspection equipment that can report open recalls. However, safety-only counties do not use the same type of equipment and cannot print out the safety recall information as part of the inspection report.

Ms. Ember Brillhart, a Honda North America company state relations representative, presented the issues associated with unrepaired recalls from the manufacturers' perspective. In general, it is the manufacturer's responsibility to get all recalls fixed to ensure consumer safety; however, reaching all owners is a challenge. Working together with States by either requiring mandatory repairs or helping notify owners of open recalls is key to preventing serious injuries or even deaths associated with recalls. Ms. Brillhart pointed out that Texas is a key Takata state, because the high heat and humidity increases the risk for the Takata airbag to fail. Honda has done everything possible to try to reach all owners about the Takata airbag recall, yet still many vehicles need to be remedied.

Ms. Brillhart mentioned two solutions with a potential of significantly ameliorating the unfixed recall issue. The first is to make open recall repairs mandatory at the State level, and the second is to leverage inspection facilities as a way to notify owners of open recalls. Incorporating recall information into the vehicle inspection report would add additional value to the Inspection Program by enhancing safety for all road users. Some specific points made by Ms. Brillhart and Dr. St. Denis about Texas included the following:

- Honda estimates that approximately 1,000,000 Honda vehicles are on the road in Texas still equipped with Takata airbags. Honda has made several different attempts to reach these motorists through Honda dealerships, newspaper ads, direct mailings, and other methods. Honda employees have also located crashed or junked Hondas, which had intact Takata airbags. These vehicles were then purchased by Honda to ensure that defective spare parts would not be resold to the public.

- One problem with making recall repairs mandatory to pass a state inspection is repair parts availability. In some instances, very large recalls might result in delays of several months before repair parts for the recall are available. Thus, it would not be appropriate to prevent a motorist from passing a state safety inspection due to unrepaired recalls due to lack of repair parts.

I.3. Breakout Group Discussion Questions

These questions were presented to breakout groups for discussion after breakouts sessions were completed.

1) The CTR study team is analyzing the following data types. Are there other types of data we should also consider? If so, do you know who we would contact to obtain this data for Texas?

- Crash Record Information System (CRIS) data	TxDOT
- Law Enforcement Officer's CR-3 crash investigations	TxDOT
- Highway Safety Improvement Program crash costs	TxDOT
- Texas Roadway posted speeds by route type and/ or lane miles	TxDOT
- Enforcement Officer's Roadside Stop Citation data	TxDPS
- Inspection Program Costs	TxDPS, TxDIR
- Vehicle Registration Data	TxDMV
- Vehicle Owner Surveys about inspections	CTR Survey
- Inspection Station Owner Surveys	CTR Survey
- In person or telephone interviews with stakeholders	CTR

2) Are there any additional factors that the CTR study team should consider regarding benefits or dis-benefits of Motor Vehicle Safety Inspections for passenger vehicles?

3) For a number of years, the City of Houston has conducted separate motor vehicle safety inspections of taxis and limos that include more factors than the Inspection Program. These inspections were conducted at a Texas motor vehicle inspection station and comprise several thousand records. If CTR obtained access to these records, do you think this information:

a) would help inform this study, though only about a small sub-set of vehicles.
b) would not be applicable to this study even if the results were reported separately from the Texas Motor Vehicle Safety Inspection analyses.

4) A Texas motor vehicle station operator has maintained detailed records about the inspection process including the number of first-time failures, the specific parts that were replaced or repairs that were made and whether the vehicle passed second inspection. This information includes thousands of vehicles inspected at 10 stations located in emissions counties and counties in which vehicle emissions testing is not required. If CTR obtained access to analyses results from these records, do you think this information:

a) would help inform this study, though only about a small sub-set of stations and vehicles.

b) should not be included in this study even if the results were reported separately from the Texas Motor Vehicle Safety Inspection analyses.
c) I am unsure

5) The CTR study team has talked with many advocates of motor vehicle safety inspections, but few individuals who opposed inspections. Can you suggest certain types of drivers, companies, commercial trade / advocacy groups or other entities that might support elimination of motor vehicle safety inspections for passenger vehicles? We would like to interview those individuals.

6) Are there improvements to the vehicle safety inspection process that could enhance highway safety in Texas? Some examples that have been discussed with stakeholders include:

a) Reporting vehicle open recalls as part of the inspection report. This is currently done only in Texas's emissions counties which use different equipment than counties which do not conduct emission testing and cannot produce recall reports.
b) Taking tire tread depth measurements across the width of the tire, not just in the center.
c) Checking electrical wiring and wiring harnesses for cracked insulation and possible other defects that could potentially result in a vehicle fire.
d) Requiring tires older than six years to be inspected on the inside for tire rot, or even requiring replacement of tires based on age.
e) Checking battery condition for leaks or other signs of defects. Batteries are sometimes mounted within the passenger compartment under a seat, or within the trunk which protrudes into the passenger space.

Are there any other inspection items that you think should be added to this list?

7) Do you think that advances in passenger vehicle design have eliminated the need for motor vehicle safety inspections in Texas?

a) If yes, which particular vehicle design advancements have made the greatest contribution?
b) If no, why do you think this is the case?

8) Do you think that advances in passenger vehicle design within the next 20 years—vehicle-to-vehicle (V2V) communications; vehicle-to-infrastructure (V2I) communications; fully autonomous vehicles—will eliminate the need for passenger vehicle safety inspections in Texas?

a) If yes, which particular future vehicle design advancements will make the greatest contribution?
b) If no, why do you think this is the case?

9) In general, do you think vehicle owners have a good knowledge about the specific items that are being checked during a vehicle safety inspection?

a) Very few vehicle owners know what is being inspected
b) Perhaps half of vehicle owners know what is being inspected
c) The majority of vehicle owners know what is being inspected

d) Not sure

If ‘very few vehicle owners know what is being inspected’, do you think that an education program for motorists is needed to improve their knowledge of the inspection process? Could this enhance highway safety?

If ‘half of vehicle owners know what is being inspected’ does this still support the need for an education program for motorists to improve their knowledge of the inspection process? Could this enhance highway safety?

If ‘Most Vehicle owners know what is being inspected’, how did these individuals learn about the Safety Inspection process and which items are inspected?

If you are ‘unsure’, do you think it is important for vehicle owners to know what is being checked during a safety inspection? Could this enhance highway safety?

10) Referring to the following two graphs [Figures I.1 and I.2], do you think this information supports keeping the motor vehicle safety inspection fee the same as it is now, increasing the fee, or decreasing the fee?

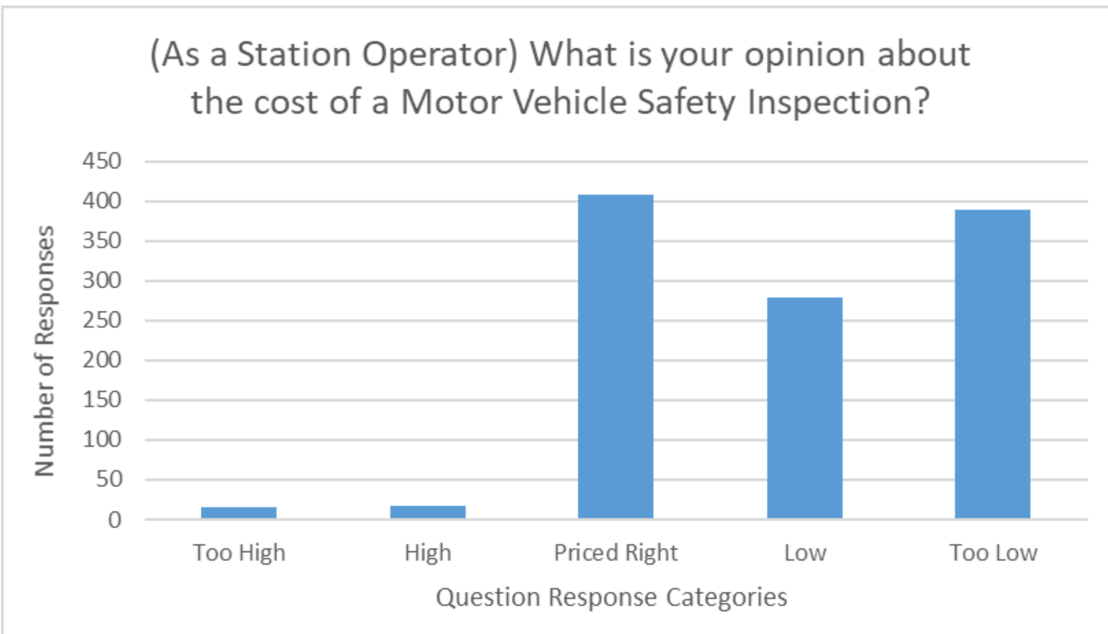


Figure I.1. Safety inspection station operators’ opinions about the cost of an inspection

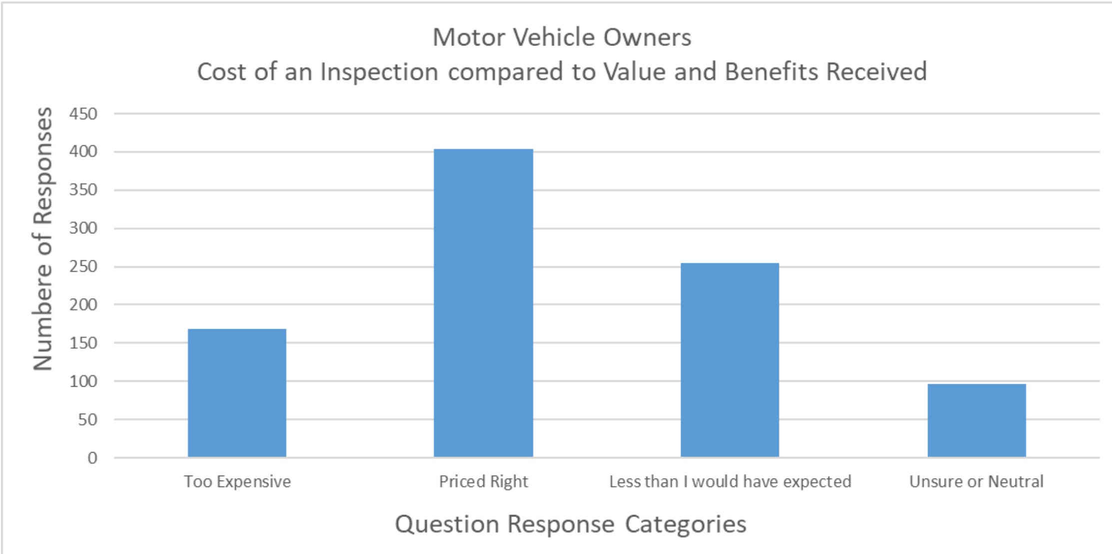


Figure I.2. Vehicle owners' opinions about the cost of an inspection

11) Texas is noted for having the highest posted speed limit in the U.S. (85 mph on a toll road between San Antonio and Austin), and the highest average speeds for rural interstates. Do you think if passenger vehicle safety inspections were eliminated in Texas this would:

a) Result in higher risk for Texans and out-of-state motorists traveling in Texas, compared to other states?
b) Result in about the same risk for Texans and out-of-state motorists traveling in Texas, compared to other states?
c) Result in lower risk for Texans and out-of-state motorists traveling in Texas, compared to other states.
d) Why or why not?

12) Based on rough estimates, it is believed that a fatality crash usually requires from four to six hours to be investigated and cleared from the roadway. Incapacitating injury crashes may require less time—though each crash might still require hours to investigate and clear from the roadway.

13) It has been stated that Texans spend 9,000,000 hours per year having their passenger vehicles inspected. Do you think that:

a) The number of hours of delay should at least equal or exceed the total number of hours Texan's spend having their vehicles inspected to demonstrate that Safety Inspections are beneficial.
b) The number of hours of delay could be less than the total number of hours Texan's spend having their vehicles inspected, but still demonstrate that Safety Inspections are beneficial. However, the number of hours of delay should be at least __________ % of the total hours of Safety Inspection time.
c) I'm unsure.

14) Did CTR miss an important question that should be discussed during the breakout session? If so, please write the question below—we may have time to discuss your question during the breakout session.

I.4. Breakout Group Discussion Summary

The following subsection reviews the answers given by stakeholders for each question.

Question 1

The first question listed all the data sources currently being evaluated by the CTR team members and asked stakeholders to suggest additional data sources that would benefit this study. Stakeholders suggested the following items:

- Consider first-time failure rates at "inspection only" stations
- Obtain inspection and failure rate information from vehicle fleet owners
- Obtain open vehicle recall data from NHTSA
- Obtain fatality crash data from FARS
- Obtain repair receipt data to calculate first-time failure rates
- Consider relevant data from neighboring states
- Evaluate motorcycle data
- Increase the number of motor vehicle survey responses
- Obtain access to an insurance claims database

Stakeholders also suggested contacting various associations that might have information, personal contacts, or data that would benefit this study. These following associations were named:

- Texas Sheriff's Association
- Texas Police Chiefs Association
- DPS Officers Association
- Houston Police Association
- Houston Police Union
- American Automobile Association
- Councils of governments (COGs) and metropolitan planning organizations (MPOs)

Question 2

This question asked whether there were additional factors that could contribute to the benefits and/or dis-benefits of the Inspection Program that should be considered by the CTR team members.

Suggestions for additional factors to consider ranged from economic factors to educational benefits. The following additional factors were mentioned by stakeholders:

- Positive economic impact resulting from higher recall completion rates
- Positive economic impact to business
- Customer services aspect of the safety inspection program
- Safety failures that cause a property-damage-only crash and are not reported
- Positive effect of vehicle safety educational campaigns
- Registration rates in states with different safety inspection frequency requirements or with no safety inspection program

The discussion handout gave an example regarding the effects of an educational campaign initiated by the State of California. As part of an educational campaign, a pamphlet describing the meaning of various engine warning lights was made and distributed to Californians. According to the workshop attendee, the pamphlet was very well received, quite popular, and overall useful to the public. There are other programs similar to this one that would be useful to review. The handout noted that the North Central Texas Council of Governments (NCTCOG) has developed a similar educational pamphlet that has been well received.

Stakeholders mentioned that the CTR team should carefully consider the validity of the data being considered. For example, some states have tweaked their safety inspection program in terms of the items reviewed. These differences in programs could make a safety inspection program seem less defendable in terms of benefits versus costs if those differences are not considered.

Another stakeholder commented that it is important to note that any perception of "savings" from dissolving the program is false because the funds would just get reallocated to another portion of the budget.

Question 3

Question 3 asked stakeholders if they believed that reviewing the City of Houston taxi and limo vehicle inspection database, which includes more factors than TxDPS state safety inspections, would help inform the study. It was mentioned that perhaps the CTR team members could mine some first inspection failure rate information from the Houston database. Concerns and comments regarding extracting information from this database included:

- Data might not be useful for PVs because taxis and limos are high mileage (500,000+ mi on odometer), which means they deteriorate faster.
- This is a small subset of data for a single location within the state.
- Every fleet has its own standards.

In general, all groups, except for one, believed that the Houston database would help this study in at least some way. The one group who did not agree that this database would help stated that that the additional factors likely only include softer items, such as a background check. One of the stakeholders in this group had previously served on the Houston City Council and remembered seeing the list of additional safety items for the taxis and limos. He believes that the fleet relies on the state safety inspection for the vehicle fleet. However, another stakeholder in a different group has participated in conducting the taxi/limo inspections for Houston for many years and did not mention that the additional factors only include soft items that would not benefit this study.

Other comments were made by stakeholders that do not directly answer Question 3, but are useful for this study. For example, it was mentioned that City of Dallas had a similar program for taxi and limo inspections that was recently suspended, but data from the program can be provided by a workshop attendee. Another comment was made about cab companies not being the only ones with vehicles deteriorating much faster than the average vehicle. Other types of ride sharing vehicles are likely putting many more miles on their own personal vehicles than the average motorist. A workshop attendee offered to provide more information about one of the new 'for hire' ride share companies.

Question 4

This question asked stakeholders whether they believed that information from one particular station operator who has maintained very detailed inspection records for ten stations he owns would help inform this study. These detailed records include the number of first-time failures, the specific parts replaced, and the whether the vehicle passed the second inspection.

The overall consensus from workshop attendees was that there is no harm in analyzing these results and that the statistics would help this study. In fact, one group mentioned that it is possible that these ten stations represent the true population group. The concerns that were mentioned regarding reviewing this database include:

- Missing first-time failure data from situations, for example, when customers are advised to fix parts upon entering the station to ensure passing before officially starting the inspection.
- Needs contextualization in terms of vehicle density/population.

Question 5

This question asked stakeholders to suggest certain types of drivers, companies, groups, or other entities that might support the elimination of the Inspection Program. In general, the political groups that veer to the hard right and are against taxes and regulations are possible supporters of the Inspection Program elimination.

Certain types of drivers and companies were suggested as potential supporters of the Inspection Program elimination:

- *Companies that have the means and desire to maintain their own fleet of vehicles.* One stakeholder suggested that AT&T might be one of those companies. With respect to the certain types of drivers that would support the elimination of the program, it was suggested that there are some people that simply do not like others touching their car. These people tend to do all their own maintenance work and believe that their car is safe and well maintained.
- *People who prefer that no one touch their vehicle*. According to a station operator, ‘people who don’t want someone else touching (or driving) their vehicle, are in the minority. It was mentioned that drivers that have many vehicles perhaps view taking all of their vehicles to get inspected as a time-consuming burden.
- *Low-income families. A*lthough the fee is affordable, might have a tight budget and feel that the fee is an issue.
- *Advocacy groups for the elderly might be possible supporters*. One group mentioned that some of the elderly might be eligible for some sort of inspection exemption. However, this claim has not been corroborated.

Question 6

This question asked stakeholders to suggest possible improvements to the safety inspection process and provide examples. The list of examples follows:

- Reporting open recalls info in the inspection report in safety-only counties.
- Taking tire tread depth measurements across the entire width of the tires.
- Checking for cracked insulation in electrical wiring and wiring harnesses.
- Inspecting tires older than six years for tire rot, and require replacement of rotting tires.
- Checking battery condition for leaks or other signs of defects.

The overall consensus was that the inspection report should list vehicle safety recall information. Questions were raised as to whether completing the safety recall should be made mandatory before issuing a new registration sticker. The problem with making recalls mandatory is there are times when vehicle manufactures are behind in producing replacement parts, as mentioned in the Takata airbag case during the plenary session. WebEx group members noted that it is not fair to hold owners at fault for something that the manufacturer cannot make available.

There were some concerns expressed with respect to the examples listed in the question. With respect to taking tread depth measurements, some tires have low profile diameters, which make measuring across width difficult or perhaps impractical. Another stakeholder questioned the value of preventing a fire hazard by checking for cracked insulation in wiring. Another stakeholder mentioned that the battery leak check is not necessary, and for batteries that are very difficult to reach this item would be cost prohibitive. Lastly, there were concerns with inspecting tires older than six years. Stakeholders suggested that 10 years seems more practical, and that in reality it is very difficult to know the age of a tire. Though after the workshop, CTR obtained information about tire date information based on a National Transportation Safety Board presentation advocating inspections for tire age, that the age is printed on the side of the tire including the week and year the tire was manufactured. Thus, 2915 would mean that the tire had been manufactured in the 29th week of 2015.

Some stakeholders suggested additional items to add to the safety inspection list. The following items were suggested:

- Add tire inflation pressure assessment.
- Check for obvious fluid leaks.
- Check headlight integrity.
- Address airbag-related items in the inspection process. According to a group expert, airbag lights are on in approximately one-third of vehicles inspected, highlighting the need.
- Improve the braking test.
- Add information on items that are technically passing, but very close to the end of their service life to the report.

There were concerns about "over-testing" as a result of trying to increase the scope of the safety inspection. For example, in newer cars an on-board diagnostic (OBD) scanner can run diagnostics to determine issues, such as problems with sensors. However, there are times when the scanner is wrong. An expert mentioned that not all inspection stations have an automotive expert present that has the ability to check whether the OBD is working well. A TxDPS member agreed and mentioned that it is best to keep the scope to a minimum by only checking the basic wear and tear items. Another point mentioned was that increasing the number of items in the list will increase the fees. However, most safety inspection items are not directly linked to the OBD; rather emissions testing items such as sensor malfunctions that can cause and engine check light to come on are connected to the OBD. A malfunctioning gas cap, which is checked during a safety inspection can also cause the engine check light to illuminate.

Question 7

This question asked stakeholders if they believed that advancements in PV design have eliminated the need for the Inspection Program in Texas. Overall, all stakeholders agreed that vehicle advancements do not eliminate the need for the safety inspection program.

Despite all the advanced safety features provided, the likelihood is high that there will be some items that the average owner will have trouble identifying or will forget to check. The safety program ensures that key wear and tear items, which pose a safety hazard to drivers and other road users, are indeed checked. Even brand-new cars have a chance of failing inspection. One stakeholder believes that up to 11% of new vehicles could fail inspection at the point of drop-off at a dealership. Stakeholders believed that the inspection provides benefits to owners, other road users, and provides the opportunity to get recalls fixed.

Question 8

Similar to the previous question, this question asked stakeholders if they believed that advancements within the next 20 years will eliminate the need for the Inspection Program in Texas. Once again, the overall group consensus was that even in the next 20 years, advancements in design will not eliminate the need for the program. Stakeholders as a whole do not anticipate that autonomous vehicles or other advancements in design will have components that are totally immune to wear and tear. In short, the safety inspection should always remain since vehicle components will always wear down.

Question 9

Stakeholders were asked if they believe that vehicle owners have a good understanding about the specific items that are checked during the safety inspection. Opinions varied across the board, but overall consensus was that the majority of people probably know at least a few items, but very small percentage know the entire list.

It was generally agreed upon that enhanced education efforts would be beneficial and are important. Suggested methods for disseminating information included:

- Posters
- Brochures
- Advertisements
- Billboards (digital and traditional)
- Direct mail
- Pamphlets describing the various check lights that appear on a dashboard, similar to ones made in California
- Social media
- Technology-based dissemination, i.e., sending out push notifications when vehicles are a determined number of days away from inspection

TxDPS group members made note that all information related to the inspection can be found online, including inspection training videos. Some challenges with respect to circulating educational information were mentioned, including:

- Some people do not care to know.
- Some people do not want to know.
- Some people do not look at educational materials, even if it is there in front of them.

Question 10

Stakeholders were asked whether they believed the data presented by two charts supported keeping the inspection fee the same or changing it. The graphs that were presented to them at the workshop are provided as Figures I.3 and I.4.

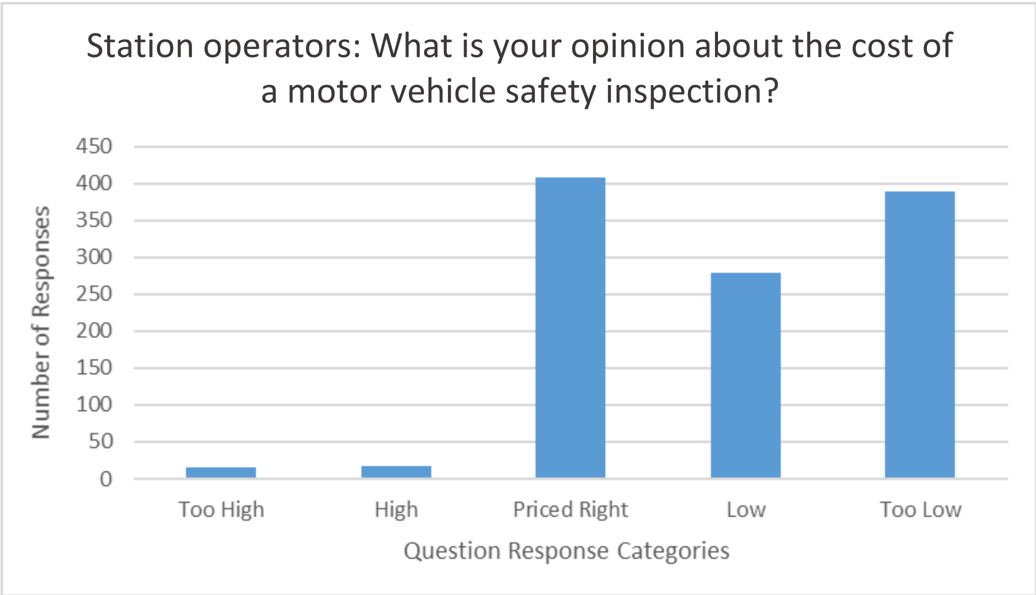


Figure I.3. Inspection station operators' opinions about the cost of an inspection

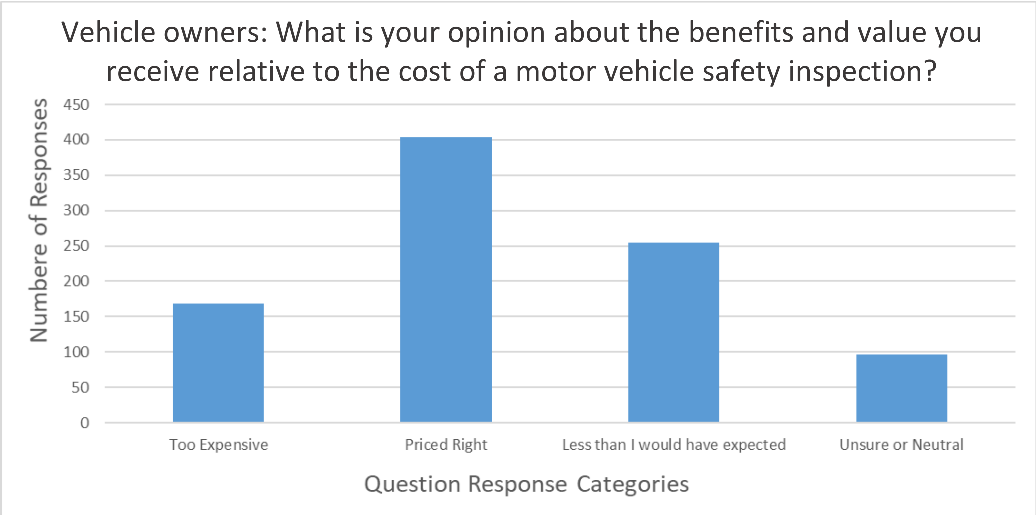


Figure I.4. Vehicle owners' opinions about the cost of an inspection

Two groups expressed concern with how the question was phrased in the survey. Specifically, this question did not clarify that the cost was supposed to be the safety fee only, which is $7.00 paid to the inspection station; an additional $7.50 fee is paid at registration. Some survey respondents may have answered based on the safety and emissions inspection, costing up to three times more than the safety-only inspection. There was also some concern with respect to whether or not this sample represents a true cross-section of the population. For example, it is not clear that the elderly or families with a low socioeconomic status are represented in this sample.

Broadly, stakeholders believe that this data can support increasing the inspection fee. One group said that most people would agree that $7 for a safety inspection is a bargain. Another mentioned that individually checking all the items on the list costs more than the pre-arranged price, especially when considering that the value of an inspector's time is undervalued with the current pricing. Those that mentioned the graphs support keeping the fee the same did mention they believed the market could tolerate a higher fee.

Question 11

This question asked stakeholders if eliminating vehicle safety inspections in Texas would affect accident risk, given the fact that Texas has the highest posted speed limit and more miles of roadway with high speed limits in the country. The question had three options: risk increases, risk stays the same, or risk decreases. One stakeholder was wondering why stakeholders were being asked about risk staying the same.

Many stakeholders remembered the presentation given in the plenary session and said that it is very clear that higher speed limit results in increased fatality risk. Various studies and anecdotal evidence were suggested to support the perception of higher risk for Texans, such as the following:

- A study from Pennsylvania showing inspections should continue.
- A North Texas Toll Authority study.
- Anecdotal evidence from South Carolina indicates numbers of crashes have increased since safety inspections were eliminated.
- Anecdotal comment noted that cars from Oklahoma are in poorer conditions than Texas vehicles, which was attributed to that state not having an inspection program.

A stakeholder mentioned a highway in Germany, which has no speed limit, but has remarkably low crash rates. In Germany, cars undergo extensive vehicle testing and inspection. These inspections are mandatory and are conducted by highly trained engineering professionals.

Question 12

Stakeholders were told that fatality crashes take about four to six hours to clear from the roadway and that Texans spend 9 million hours a year getting PVs inspected. This question asked stakeholders to state the relationship (equal, exceed, other) between hours of delay and hours of inspection would show that safety inspections are beneficial.

Out of the six groups, only one suggested a relationship for the hours of delay to hours of inspection to show the benefit of time spent getting an inspection. The group suggested that the hours of delay should at least equal the hours spent getting an inspection. Every other group mentioned that this comparison does not make much sense.

Stakeholders mentioned the following concerns with respect to this comparison:

- Validation of the 9 million hours estimate in general. For example, inspections during the middle of the month usually have less wait time.
- The value of time for ensuring safety and the value of time for convenience are not the same.
- Not clear if the time saved since Texas went stickerless is factored in.
- Need to disaggregate data on regular congestion from incidence times to determine the calculation versus inspection time.
- Need very accurate data on incident clearance.
- Need to clean data points to adjust for time taken for other maintenance and the inspection is an ancillary add on.

Overall, stakeholders agree that without a safety inspection program, there will be more crashes on Texas roadways, causing more time spent in traffic for users.

Question 13

Stakeholders were asked if they believed serious crashes resulting in totaled vehicles could result in negative impacts to the environment. Comprehensively, the group agreed that one or more totaled vehicles could result in negative impacts to the environment. One group commented that it will probably be difficult to quantify the impact with the data sources that are available. Possible environmental impacts were suggested, such as:

- Petroleum product leaks.
- Hazardous material spills.
- Broken vehicle parts and debris.
- Vehicle fire.
- Smoke.
- Increased emissions from congestion.
- Battery leaks.

A stakeholder suggested that the impacts might be different if a crashed vehicle remains on the road versus drives to a different location.

Question 14 (Other Issues)

Stakeholders had an opportunity to discuss other issues, comments, or opinions that were did not pertain specifically to the list of questions. The feedback gathered was combined and is described below:

On Inspection Stations in Texas

- There are too many stations and too many inspectors in Texas.
- Some inspection stations do not necessarily do a thorough job conducting a safety inspection, which casts doubt on the integrity of the program.
- TxDPS conducts audits of safety inspection stations, but it is unknown how effective these audits are in eliminating inspection stations that ‘sell’ passing inspection reports.

However, these comments are points of view based on anecdotal evidence and not currently substantiated with facts or data—at least based on what has been provided to the CTR study team.

TxDPS does not have the authority to deny an individual from applying for an inspection station license and being approved to conduct safety inspections as long as the state guidelines and rules are met. Additional authority and resources should be provided to TxDPS to provide more effective management of inspection stations and the inspection program.

On the opposing side, one group commented that there were an insufficient number of inspection stations for the 22 million inspections conducted in Texas last year.

On the Data Collection Effort

- As a whole, the surveys as presented seemed complete to stakeholders; however, better outreach efforts are needed.
- Local law enforcement agencies are responsible for the majority of accident reporting, and for non-fatality crashes level of detail might be lower than needed for this study.
- Some stakeholders believe that law enforcement does not have the ability to visually identify more complex mechanical defects, and that there is a significant degree of vehicle defect under-reporting in CR-3 reports.
- The CTR team should visit an inspection station to gain insights on first-time failure rates.
- The CTR team should consider trailer inspection data.

Miscellanea

- Dealership owners might support the legislation promoting complete vehicle inspections to increase revenues. Complete inspections costs $25 instead of $7.
- Long waiting times should not motivate the abolishment of the Inspection Program. Some station operators indicated that the number of drivers requesting an inspection increases significantly during the last and first week of the month, increasing wait times for this group.
- CTR should estimate the potential increase in Texas liability insurance rate as a result of abolishing the program.

Appendix J. Vehicle Owner Online Survey

CTR developed an online survey (shown below) to obtain information regarding the public's experience with and opinions about the costs and benefits of PV safety inspections. UT is licensed to use the Qualtrics™ online survey and data analysis tools.

--Reproduction of Online Survey ---------------------------------

Information only

Texas Motor Vehicle Safety Inspection Program Survey

The State Legislature has required the Texas Department of Public Safety (DPS) to report on the costs and benefits of the Texas Motor Vehicle Safety Inspection Program. DPS has contracted with the University of Texas at Austin – Center for Transportation Research to assist in preparing this report. Your participation in completing this survey is much appreciated.

If you have any questions regarding this survey, please contact:

Dr. Mike Murphy, P.E.
(512) 232-3134
michael.murphy@engr.utexas.edu

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

Page Break

Q1 Please tell us the location of the Vehicle Safety Inspection Station where you often have your vehicle inspected:

- ◯ City: (1) ____
- ◯ County: (2) ____

Q2 What is your gender?

- ◯ Male (1)
- ◯ Female (2)

Q3 Please tell us more about your vehicle:

- ◯ Year: (1) ____
- ◯ Make: (2) ____
- ◯ Model: (3) ____

Q4 Do you think having a Vehicle Safety Inspection Program improves highway safety in Texas?

- ◯ Strongly agree (1)
- ◯ Somewhat agree (2)
- ◯ Neither agree nor disagree (3)
- ◯ Somewhat disagree (4)
- ◯ Strongly disagree (5)

Q5 Do you think that having your vehicle inspected annually helps improve highway safety?

- Definitely yes (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q6 Do you think having your vehicle inspected takes too much time?

- Definitely yes (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q7 Please indicate your opinion about the money you pay for a Motor Vehicle Safety Inspection:

- I regard it a "tax" for which I receive a service (1)
- I regard it a "fee" for which I receive a service (2)
- I am unsure if it is a "tax" or a "fee", but I do receive a service (3)
- I am unsure if it is a "tax" or a "fee", but I don’t think I receive a service (4)

Q8 Do you think vehicles on the road that have defects (e.g., slick tires, bad brakes, head or tail lights out, signal lights not working, steering problems) could contribute to an accident?

- ○ Definitely yes (1)
- ○ Probably yes (2)
- ○ Might or might not (3)
- ○ Probably not (4)
- ○ Definitely not (5)

Q9 Do you think for the benefits and value you receive, the cost of a Motor Vehicle Safety Inspection is:

- ○ Too Expensive (1)
- ○ Priced right (2)
- ○ Less than I would have expected (3)
- ○ Unsure or Neutral (4)

Q10 In the past, have you had a Motor Vehicle Safety Inspection which found a safety problem that required repairs or replacement parts for your vehicle? (check all that apply)

- ☐ Yes, repairs or replacement parts were needed. The Inspection Station was able to fix the problem. (1)
- ☐ Yes, repairs or replacement parts were needed. However, I had to take my car elsewhere to have the repairs done. This took more time. (2)
- ☐ Yes, repairs or replacement parts were needed. However, I bought the parts and did the repair myself or with relatives/friends. This took more time. (3)
- ☐ No, my vehicle has never needed any repairs or replacement parts (4)

Q11 If you have had repairs or purchased replacement parts as a result of a Motor Vehicle Safety Inspection, please indicate the number of times this has happened over the years:

____

Q12 If you have had repairs or purchased replacement parts as a result of a Motor Vehicle Safety Inspection, what types of repairs or replacement parts were needed? (check all that apply)

- ☐ Worn, slick or defective tire(s) (1)
- ☐ Headlight was out (2)
- ☐ Tail light was out (3)
- ☐ Signal Light(s) were out (4)
- ☐ Horn was not working (5)
- ☐ Muffler needed replacement (6)
- ☐ Windshield Wiper Blades needed replacement (7)
- ☐ Steering mechanism needed repair (8)
- ☐ Worn brakes which needed adjustment or replacement (9)
- ☐ Other reason(s) (Please specify in the next question) (10)

Q13 You selected other reason(s) in the last question, please specify them here:

____

____

____

____

Q14 If your vehicle needed a repair or replacement parts before it would pass a Safety Inspection, please indicate which of the following statements are true. (check all that apply)

- ☐ The vehicle inspector noticed the problem before the Inspection was performed and told me to have the problem repaired, then bring my vehicle back for the Inspection. (1)
- ☐ The vehicle inspector talked to me after the inspection had started and told me I needed repairs or replacement of parts that could be done by the Inspection Station. If the repairs were not done, my vehicle would not pass. I had the Inspection Station make the repairs. (2)
- ☐ The vehicle inspector conducted the Inspection, found a problem and failed my Vehicle. I then had the repair made at another location and brought my vehicle back for a 2nd inspection. This took additional time. (3)

Q15 Do you pay more attention to your car's maintenance during the year because you know that your car must eventually pass a Motor Vehicle Safety Inspection?

- ○ Definitely yes (1)
- ○ Probably yes (2)
- ○ Might or might not (3)
- ○ Probably not (4)
- ○ Definitely not (5)

End of Block: Default Question Block

The survey was designed to provide the CTR study team with anonymous information from both male and female drivers from all regions of the state. The primary distribution methods included the following:

1. A poster was developed for placement in over 6,500 inspection stations. The poster provided a brief explanation of the purpose of the survey and provided a QR Code and the URL for the online survey (Figure J.1).

Figure J.1. Poster advertising the vehicle owner survey

2. TxDPS posted a link to the survey on the Inspection webpage of the TxDPS website.
3. CTR posted the link to the survey on its various social media pages (Facebook, Twitter, etc.)
4. The following councils of governments (COGs) and metropolitan planning organizations (MPOs) posted the survey link on their social media pages.
    a. Corpus Christi MPO

   b. Alamo Area COG
   c. Texoma COG
   d. Brownsville MPO
   e. Harlingen-San Benito MPO
5. The following COGs and MPO agreed to distribute the survey link to individuals using their email distribution lists.
   a. North Central Texas COG
   b. Deep East Texas COG
   c. Heart of Texas COG
   d. San Angelo MPO
6. CTR obtained email addresses by examining many different online sources including town and city chambers of commerce, Texas associations and advocacy groups, and random searches for email addresses based on job types (house painter, welder, real estate agent etc.). In addition, the selection of faculty and staff emails from both public and private universities, community colleges, independent school districts, and many other sources were used to obtain the required number of completed surveys to provide a statistically significant sample size for different survey categories.
   a. This approach was taken since other methods that were implemented early in the study, though helpful, were not providing a sufficient number of surveys to achieve a statistically significant sample size for the various disaggregation methods CTR intended to use to study the data.
   b. A Texas resident email address data source was not available to the study team members from which random email addresses could be selected.
   c. Purchasing a sufficient number of email addresses from a private company to obtain the desired sample size would have been prohibitively expensive. However, purchasing a random selection of email addresses from one or more private companies may not have accomplished study objectives in any case, as described in the following sections.
   d. A purely random selection of email addresses for Texas residents, though in any case not available, was considered to be inappropriate for this particular study for the following reasons:
      i. Texas has a population of approximately 25 million people based on the 2010 US Census and just over 28 million based on 2017 state population estimates (US Census Bureau, 2012). The US Census Bureau methodology for determining rural, mostly rural, urban, and mostly urban county designations was used in this study based on US Census Bureau definitions and information (US Census Bureau 2012) (US Census Bureau 2016). Surveys were distributed to ensure all four county designations were sampled.

ii. Approximately 76% of the state's population lives within the Texas Triangle megaregion (see Figure J.2), which is encompassed by Dallas-Ft. Worth in the north, Austin-San Antonio in the southwest, and Houston-Galveston in the southeast (America 2050, n.d.) (Harrison and Johnson 2012).

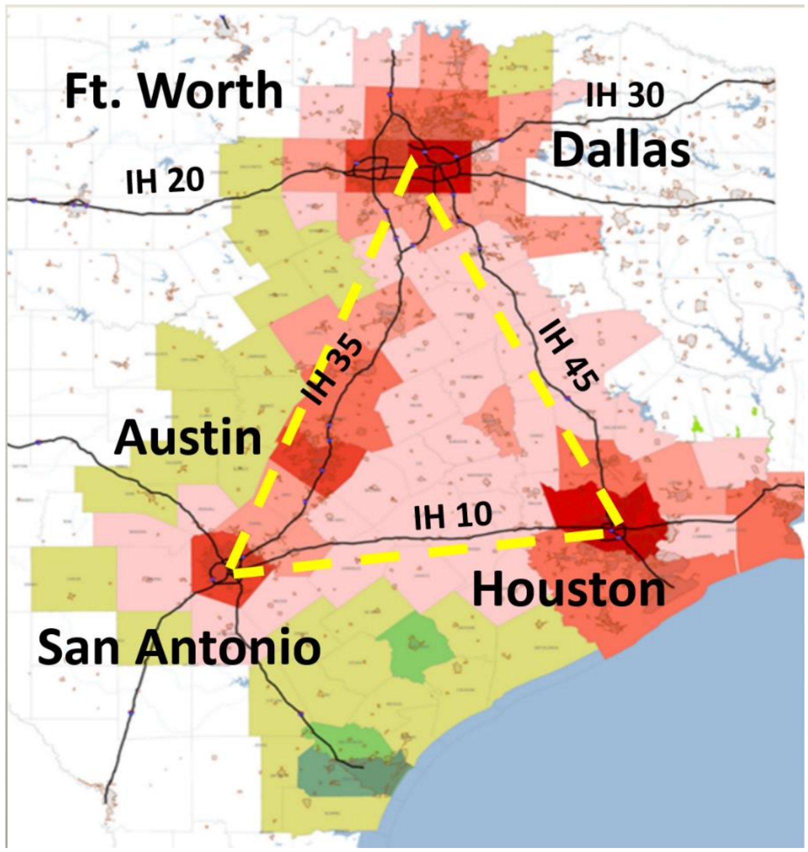


Figure J.2. Texas Triangle megaregion (bounded in yellow dashed line) modified from Harrison et al. 2012

iii. Approximately 84% of the Texas population lives in urban or partially urban counties, based on the US Census Bureau definitions, which encompass the Texas Triangle megaregion and additional smaller cities outside the megaregion. The remaining 16% of the population live in rural or mostly rural counties

iv. The CTR study team made the decision that only email addresses that contained a person's initial and last name or a first and last name would be used in the emailed invitations. Thus, the team did not purposefully send email invitations to a business email address or other similar addresses with, as examples, an impersonal prefix such as info@, Receptionist@, or bidestimate@. During the search for email addresses meeting these criteria, the team noted that females are more likely to include their first and last name or initial and last name in a business email address than are males. Thus, though the study team did not purposely choose to send emails to either males or females, or record the number of emails sent to male or female recipients, based on experience more invitation emails were sent to females than males. However, the study team found that when receiving completed survey responses, throughout the course of the email survey invitation campaign, more males than females responded based on survey responses.

Thus, as invitations were distributed, consideration was given to county location within the Texas Triangle megaregion, the US Census county definitions based on county population distribution (urban, mostly urban, rural, or mostly rural), and other factors when selecting and distributing emails. If emailed invitations had been distributed purely randomly to Texas counties without regard to population, this may have resulted in under- or over-representation of one or more of factors. These factor include, but are not limited to, 1) emissions and safety inspection counties (17 out of 254 counties) versus safety-only inspection counties (237 out of 254 counties); 2) sufficient numbers of survey responses from rural county residents and Texas Triangle counties in consideration of local and regional populations; and 3) adequate representation from each region of the state, such as West Texas, which may have one or two counties with a large population surrounded by several counties with very small populations (e.g., El Paso, Lubbock, Amarillo, Midland, and Odessa).

v. For purposes of the following discussion, a "completed survey" is one that the Qualtrics Data & Analysis metadata indicated is 100% complete. This means that all questions in the survey contained a response, though the survey respondent might not have indicated their location, gender, or type of vehicle. However, the vast majority of all completed survey responses also included gender, city, county, and vehicle information.

Through these methods approximately 69,200 invitations to participate in the online survey were emailed by CTR statewide to every county. However, as survey responses were received from various counties, it was found that the response rates varied significantly between urban and rural areas. At the time of this writing, approximately 1,096 completed surveys have been received from rural or mostly rural counties, which required sending nearly 26,000 emailed survey invitations—this represents a response rate of approximately 4%. Approximately 4,841 completed surveys have been received from urban or mostly urban counties, which required sending approximately 43,200 email survey invitations—which represents a response rate of approximately 11%. Approximately 99 surveys have been received from survey participants who did not provide gender and/or city/county information, though all survey questions about their inspection experience were answered.

Thus, in total, 5,937 surveys were received for which all questions related to the motorist's vehicle inspection experience and opinions were completed, though of this number, 5,839 surveys also contain gender and city/county information. At least 1 and as many as 460 completed surveys were received for 234 out of 254 counties in Texas. Thus, 20 counties provided no survey responses; however, these include certain rural counties with extremely small populations such as Loving County (population 82), King County (population 286), and Borden County (population 641).

vi. The calculations shown in bullet v. include but did not separate out the 216 surveys (170 completed) received from vehicle owners who used the QR code on the posters located in inspection stations. Further, it is not possible for the CTR study team to separate survey responses received from vehicle owners who used the URL links on the posters; CTR, MPO, COG, and TxDPS websites; or the email invitations distributed by the COGs and MPOs—though CTR certainly appreciates this support.

vii. The email message that accompanied the survey invitation included the study team leader's office phone and email address in case questions occurred. It is estimated that approximately 50–60 phone calls and 20–30 response emails were received from survey invitation email recipients, primarily requesting verification that the survey was legitimate prior to clicking the hyperlink that accessed the survey. In some cases the caller would be the IT support person for an organization, who would verify the legitimacy of the email survey invitation and then advise those he supported that it was ok to click the hyperlink and take the survey.

viii. It should be noted that since not all Texans have broadband internet access, not every Texan could have been reached by an emailed survey invitation or by internet access to the TxDPS website or MPO/COG social media page links to the survey.

The US Census Bureau estimated that in 2016 approximately 80.5% of Texas households had broadband internet subscriptions (Ryan C. & Lewis J., 2018). To some degree the number of people who could be reached by email would be increased by the fact that many invitation emails were sent to business, public school, university, or other non-residential email addresses if a person's name was part of the address.

The 2015 report *Connected Texas* estimated that approximately 105,000 Texas businesses did not have broadband internet access. However, there is no way to determine how this might have affected the total percentage of the Texas population that can be reached by email (Connected Texas 2015).

The CTR team considered it impractical to send surveys to residents by mail since it could not be determined who did or did not have access to the internet and also had an email address. In addition, telephone survey interviews were also considered impractical.

ix. The Qualtrics analytic tools provide a histogram of responses that peaked within a day or two of email distributions and returned to typical response rates of from one to five surveys per day once email distribution responses had dissipated. Dissipation of survey response rates typically occurred with two to four days after the initial email campaign distribution.

Again, all survey responses received were anonymous, though the city and county of the participant was requested, but not required. Qualtrics does provide GPS coordinates as part of the metadata that accompanies a survey response, but based on discussions with the Qualtrics data support team, the GPS coordinates are only accurate to the city level and cannot be used to determine the exact location where a survey was actually submitted. The team also noted that there were 46 surveys in which all questions were answered, but the survey respondent did not provide city or county information and the GPS coordinates normally provided by Qualtrics metadata were absent.

Table J.1 summarizes these surveys according to different factors that were used to disaggregate and evaluate the data.

Table J.1. Vehicle owner inspection survey categorized by factors

Factor	Number of Texas Counties	Number of Counties from which at least 1 Survey was received	Total Population	Number of Completed Surveys Received
Urban Counties	22	22	16,288,524	2,603
Mostly Urban Counties	96	93	6,358,362	2,154
Rural Counties	58	43	233,396	186
Mostly Rural Counties	78	76	2,291,818	896
County name not stated				98
Totals	**254**	**234**	**25,172,100**	**5,937**
Emissions and Safety Inspection County	17	17	**14,206,933**	2,471
Safety Inspections only County	237	217	**10,965,167**	3,368
County name not stated				98
Totals			**25,172,100**	**5,937**
Male				3,167
Female				2,714
Gender not stated				56
Totals				**5,937**
Vehicle year, make and model provided				**5,912**

J.1. Reviewing Survey Responses to Identify "Careless Responses"

The CTR study team downloaded surveys from the Qualtrics Data & Analysis website on a routine basis. Each survey response was examined to eliminate responses that did not apply to the study and "careless responses," which were considered to contain either intentionally or unintentionally inaccurate data that could not be used in the analysis (Meade & Craig, 2012). Examples of data that was removed from the survey and are not included in the previous statistics include:

a. Respondents who listed a commercial motor vehicle (CMV) such as an 18-wheeler tractor or a commercial bus as the vehicle for which their Safety Inspection question responses applied.

b. Respondents who listed a school bus as the vehicle for which their safety inspection question responses applied.

c. Respondents who listed a vehicle which did not represent any known vehicle type, such as:

   - 1906 Lincoln Emperial
   - 2018 UT Longhorn

d. Respondents who listed an exotic or unusual vehicle and provided questionable responses that were considered unlikely, such as:

   - 2018 Lamborghini Haracan, was inspected, a problem was found; however, the inspection station was able to repair the problem.
   - This vehicle is an exotic, $350,000 sports car. A 2018 model would have been purchased with a two-year inspection such that an inspection would not be required in 2018.

e. The Qualtrics metadata includes the total number of seconds a respondent took to open, complete, and submit a survey, which was converted during the analysis to minutes to complete the survey. The average time for a female to complete the survey was calculated to be 5.2 minutes. The average survey completion time for a male to complete the survey was determined to be 5.7 minutes. The median completion time was 4.0 minutes.

   - Surveys with unusually long completion times extending to hours or even days were closely examined to ensure survey responses were sensible.
   - Surveys with unusually short completion times, usually considered to be less than 2 minutes, were closely examined to ensure survey responses were sensible.

f. The CTR study team contacted Qualtrics technical chat support to discuss survey responses that seemed unlikely to be valid.

   - The data support person was asked to review five survey responses submitted from the same city and county within seconds of each other. Various metadata were examined by Qualtrics™ data support and the responses considered valid.
   - The CTR team reviewed selected survey responses to ensure data validity. For example, several surveys were received soon after an email campaign that had the same make of vehicle though different vehicle ages and models. After examining other data provided in the survey, these were determined to be valid.

J.2. General Statistics based on Survey Responses

The following information provides general statistics about the survey data, which was checked with other data sources to determine reasonableness and/or validity for analysis. The CTR study team established a 95% significance level with +/- 3% error for all analyses based on vehicle owner survey data.

1. TxDMV provided three years of vehicle registration data that was used to determine the average vehicle age in Texas (2010). It was found that the average vehicle age for all survey respondents was 2010.6, which rounded to 2011 but was considered reasonable. It was further determined that on average, males drive 2010 model year vehicles while, on average, females drive 2012 model year vehicles. Table J.2 provides a summary of the number and percentage of vehicles described in the survey responses. Note, due to the small number of entries, information was not provided for recreational vehicles (RVs) though these vehicles are considered a type of PV in Texas and therefore are subject to this study. A total of 5,912 vehicles are identified in this table.

Table J.2. Vehicle types, quantities, and percentages from the motor vehicle inspection surveys

	Passenger car	Compact Car	Hybrid passenger car	Hybrid SUV	Electric Car	Sports car	Pickup
Number of Vehicles	1,036	539	95	17	13	217	1,631
Percentage of total Vehicles	17.5%	9.1%	1.6%	0.3%	0.2%	3.7%	27.6%

	SUV	Compact SUV	Crossover	Station Wagon	Van	Motorcycle	Scooter
Number of Vehicles	1,668	330	73	53	139	77	1
Percentage of total Vehicle	28.2%	5.6%	1.2%	0.9%	2.4%	1.3%	0.0%

Note: According to manufacturers, a sport utility vehicle (SUV) is based on a truck chassis, while a crossover is an SUV-type vehicle based on a car chassis.

The vehicle type information was used along with information available from vehicle parts dealers to determine the weighted average cost of different types of repair or replacement parts identified by survey respondents. Table J.3 provides a summary of the number of repairs made, percentage of total repairs, and total cost of each type of repair/repair part based on the more common repairs identified in the survey. Thus, 5,597 repairs of different types are identified out of 5,620 repairs or replacement parts that were actually identified. These additional repairs include items such as serpentine belt replacement and other less commonly listed items. A total of 2,957 survey respondents indicated that repairs or replacement parts were needed to pass inspection.

Table J.3. Repairs and repair parts identified in the motor vehicle inspection survey

Repair Part	Defective or Slick Tires	Head Light	Tail Light	Signal Light	Windshield Wiper Blades	Worn or Defective Brakes	Muffler	Exhaust Leak
Number of Repairs noted by Survey Respondents	695	526	1,117	632	1,579	309	183	11
Percentage of Respondents who had this repair	23.5%	17.8%	37.8%	21.4%	53.4%	10.4%	6.2%	0.4%
Estimated Cost of Repairs	$129,409	$52,600	$88,243	$50,560	$47,370	$68,289	$88,735	$550
Repair Part	**Parking Brake**	**Window Tint**	**Steering Mechanism**	**Horn**	**License Plate Light**	**Gas Cap**	**Seat Belt mal-function**	**Mirror**
Number of Repairs noted by Survey Respondents	27	49	51	201	111	92	8	6
Percentage of Respondents who had this repair	0.9%	1.7%	1.7%	6.8%	3.8%	3.1%	0.27%	0.2%
Estimated Cost of Repairs	$2,862	$9,865	$12,427	$25,728	$3,212	$7,176	$400	$300

The reader should note that this information was provided by the survey respondents based on their experience having a vehicle inspected over a period of years, not a single year. Respondents indicated that in some cases, they had failed inspections anywhere from once to 15 times—up to every time a respondent had their car inspected. Thus, these repairs and information do not represent a single year or point in time. Rather this information represents the programmatic first-time failure and repairs conducted over the periods of time that these survey respondents had vehicles inspected. In some cases, the respondent might have only ever had one safety inspection in Texas; in other cases, 30 or more years of safety inspections. However, the programmatic (rather than an annual) first-time failure rate provides a broader picture of the effectiveness of safety inspections in addressing vehicle defects and repairing those defects.

Thus, for a total of 5,912 vehicles (vehicle owners) identified in the survey, 2,957 vehicle owners indicated that they had had first-time failures that comprised 5,620 repairs or replacement of parts. The actual calculated percentages for survey respondents who reported first-time failures and the need for repairs and replacement parts is approximately 50% of all respondents. However, calculations of the number of survey respondents indicating they had never had repairs or replacement parts does not also equal 50% for two reasons.

1. Some individuals who indicated they had never had a repair or needed a replacement part did in fact list repairs or replacement parts such as windshield wipers, gas caps, and other items.
2. A certain percentage of individuals who indicated they had never had a repair or needed a replacement part also indicated that the safety inspection station owner or inspector had first noticed a defect on their vehicle and advised the vehicle owner to have the defect repaired, then bring their vehicle back for inspection.

   Based on calculations performed using the survey data, approximately **24.9%** of individuals who indicate they have never had repairs were told by the inspection station that their vehicle had a defect that should be repaired before the inspection was performed.

Thus, if not notified by the inspection station, these individuals would have been included in the first-time failure group. According to the survey responses, (5,912 – 2957) = 2,955 survey respondents indicated they had first-time failures, but were told to have defects repaired before the inspection. Thus, 2,955 respondents x 24.9% = 736 respondents who actually would have had first-time failures if not notified by the inspector. This results in 2,219 individuals who actually have never had parts replaced or repairs made, which constitutes 37% of the total respondents. Therefore the actual, programmatic first-time failure rate is 1 – 37% = 63% of survey respondents.

Again, it is important to note that this figure does not represent the annual first-time failure rate for the survey respondents; rather, this figure represents the first-time failure rate over the period of time that this group of drivers have had their cars inspected. To recap, 37% have never failed an inspection and 63% have failed an inspection at least once, and up to several times over this period of years.

J.3. Survey Responses regarding Inspections and Highway Safety

The following sections provide a series of figures that explain what this group of survey respondents think about safety inspections in terms of enhancing highway safety, the cost and time spent having their vehicle inspected, and additional explanatory factors.

Figure J.3 shows the number of respondents who think that vehicles with defects can contribute to an accident. Defects are defined as the components that are evaluated during a routine safety inspection, such as defective or slick tires, defective or no brakes, defective steering mechanism, inoperable headlights, tail lights and/or signal lights, horn, and other items.

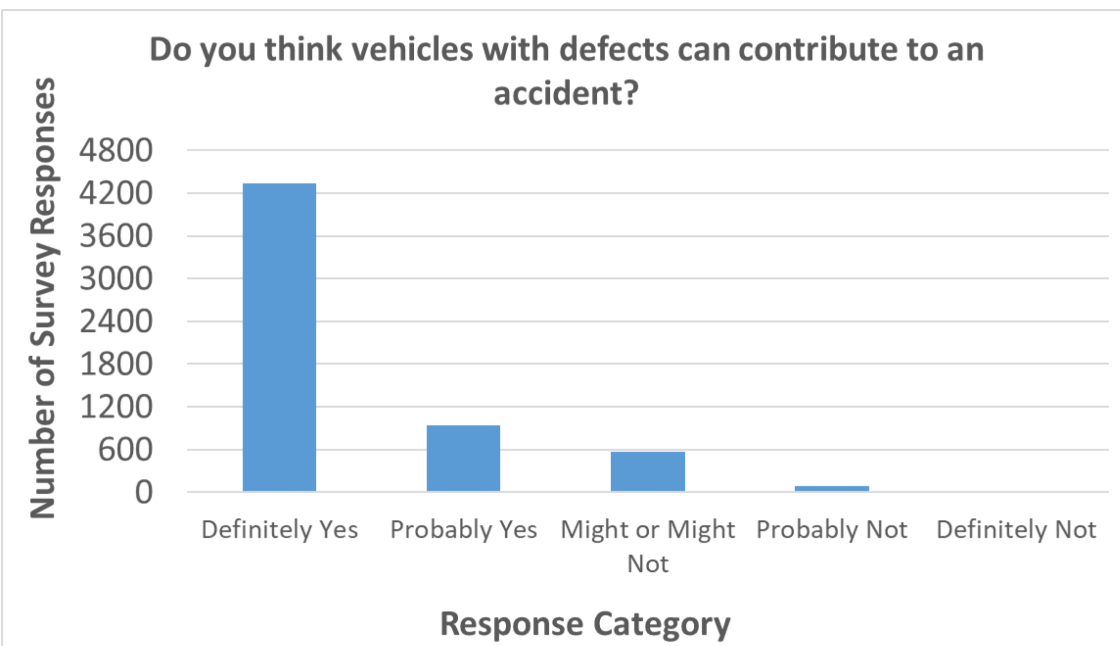


Figure J.3. Number of respondents who think that vehicle defects can contribute to an accident

Figure J.4 shows the number of respondents who think that safety inspections either do or do not benefit highway safety in Texas.

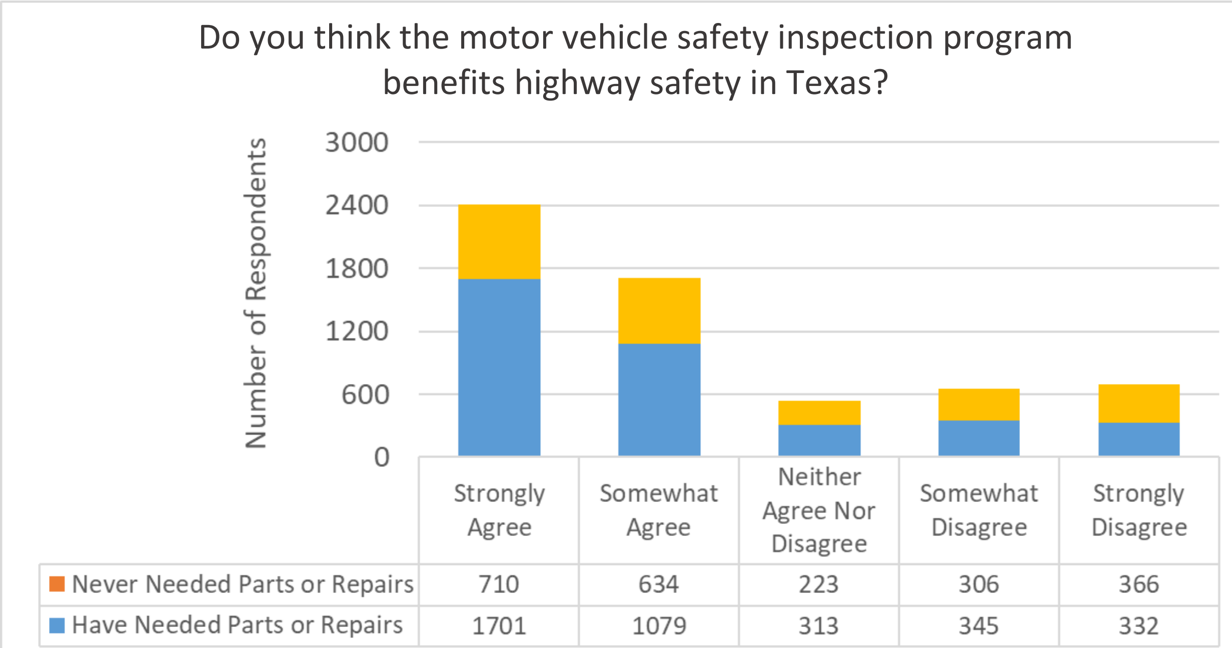


Figure J.4. Number of respondents who think the Inspection Program benefits highway safety

Approximately 4,124 respondents indicated that they ‘strongly’ or ‘somewhat agree’ that vehicle inspections benefit highway safety in Texas while approximately 1,349 respondents indicated that inspections ‘definitely’ or’ probably did not’ benefit highway safety. It is important to note that of the 4,124 respondents who strongly or somewhat agree, approximately 1,344 (32.6%) have not required repairs or replacement parts; thus, approximately 67% of respondents have required repairs or parts. Further, of the 1,349 who strongly or somewhat disagree that vehicle inspections benefit highway safety, approximately 672 (49.8%) have never had repairs or required replacement parts during an inspection

Figures J.3 and J.4 show vehicle owners’ opinions about whether vehicle defects might contribute to crashes and whether safety inspections benefit safety in Texas.

Figure J.5 provides information about whether vehicle owners think that safety inspections of <u>their vehicle</u> benefits highway safety. Approximately 3,572 (60%) of respondents indicated that they ‘strongly’ or ‘somewhat agree’ that vehicle inspections benefit highway safety in Texas while approximately 1,656 (27.9%) of respondents indicated that inspections ‘definitely’ or ‘probably did not’ benefit highway safety.

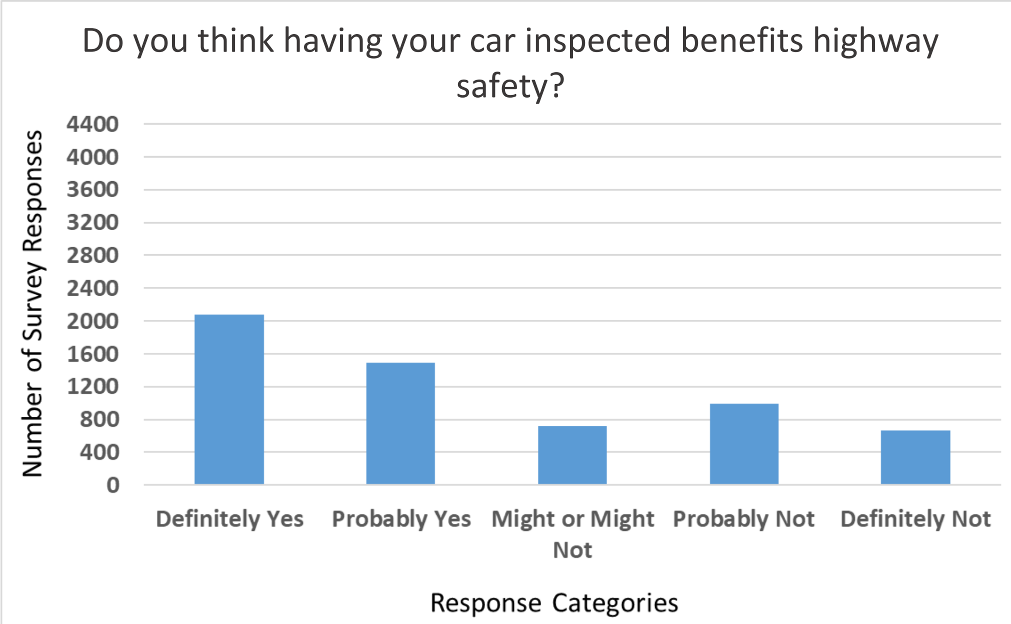


Figure J.5. Responses to the question "Do you think having your car inspected benefits highway safety?"

Figure J.6 provides information about whether vehicle owners think that the Inspection Program influences them to pay more attention to their vehicle's maintenance because they know their vehicle must eventually pass inspection. Approximately 2,682 (45.6%) of respondents indicated 'Definitely' or 'Probably Yes' while approximately 2,516 (42.8%) of respondents indicated that they 'Definitely' or 'Probably [did] Not' pay more attention to their vehicle's maintenance because their vehicle would eventually need to pass inspection.

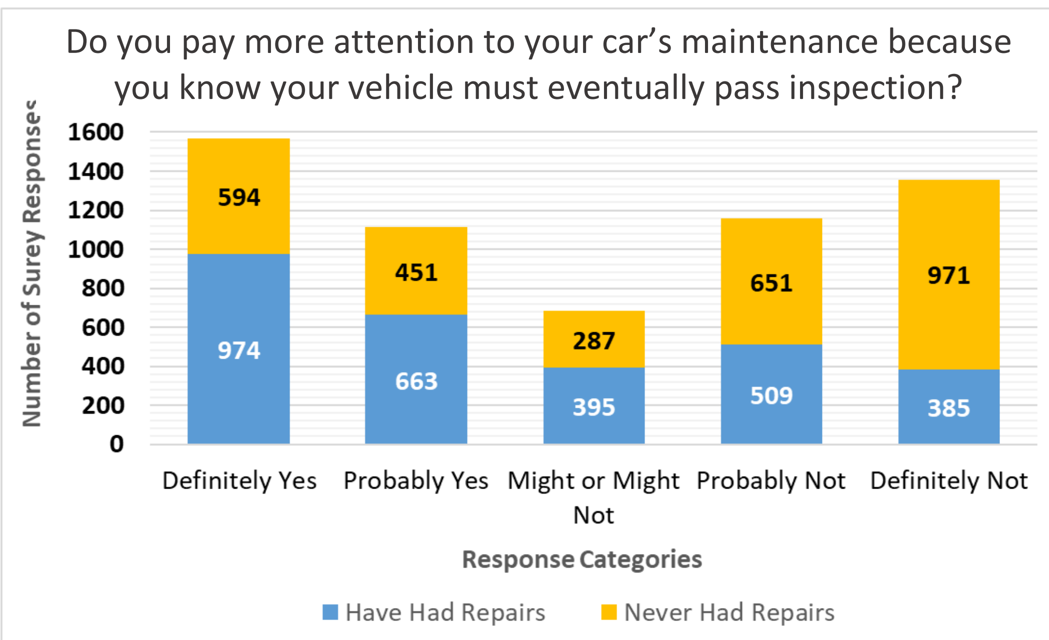


Figure J.6. Responses to the question "Do you pay more attention to your car's maintenance because you know your vehicle must eventually pass inspection?"

It is further noted that some survey respondents expressed opinions about the fact that they take care of their vehicle as needed and do not wait until the inspection program to have repairs made.

However, there are also individuals who maintain their vehicles in preparation for the annual vehicle safety inspection or wait until their car is inspected to conduct needed maintenance or repairs. A separate document has been prepared with vehicle owner comments and can be obtained by making a request to TxDPS or CTR.

Figure J.7 provides information regarding whether vehicle owners think they are receiving a service by having their vehicle inspected.

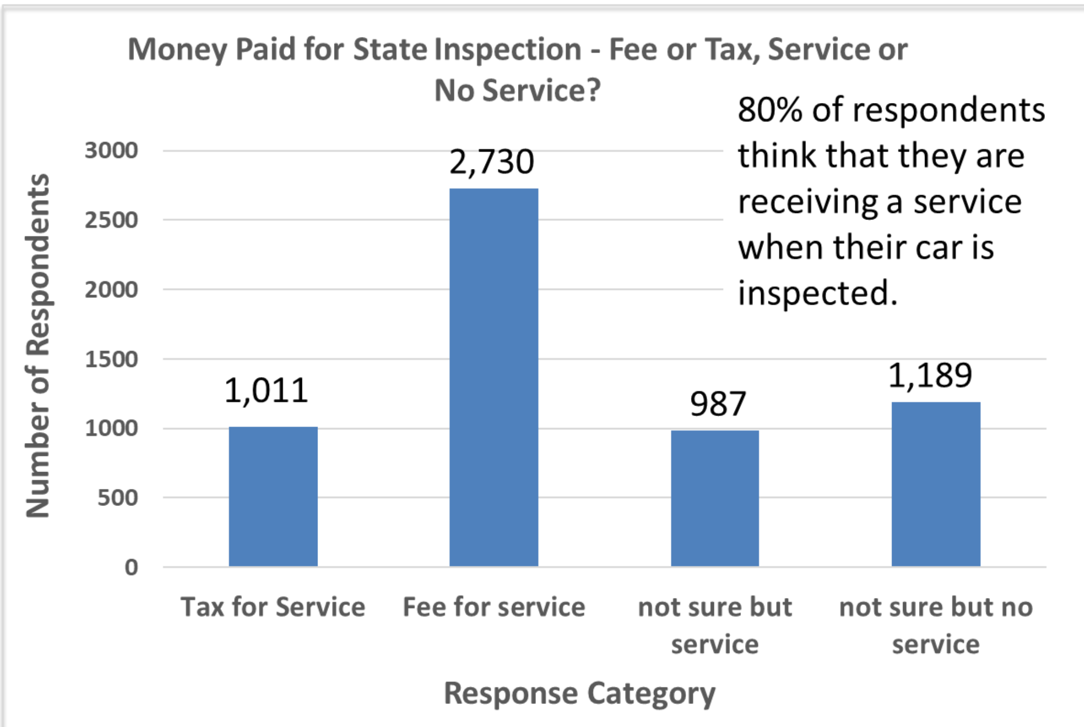


Figure J.7. Responses to the question "Do you think you are receiving a service when having your vehicle inspected?"

Approximately 80% of respondents think they are receiving a service when having their car inspected while 20% of respondents do not think they are receiving a service.

Figure J.8 shows the responses to the question regarding vehicle owners' interactions with the inspection stations with regard to obtaining repairs at the station during inspection or through other sources. Based on this information, about 48.6% of respondents indicated that they had never had repairs or replacement parts. However, as mentioned previously approximately 24.9% of these individuals were advised prior to the inspection that their vehicle had one or more defects that needed repair prior to the beginning of the inspection. Thus, though no adjustment is made in these numbers or the graph, approximately 750 respondents who indicated that they had never had repairs would have had repairs made 'elsewhere'—that is, at another business location—or would have purchased the parts and made the repairs at home. Since it was not possible to distribute these 750 responses to other categories based on available information, no adjustment was made.

Thus about 21.6% of respondents indicated that the inspection station made the necessary repairs, approximately 15.6% of respondents had repairs made elsewhere (another business), and approximately 14.1% of respondents made the repairs at home.

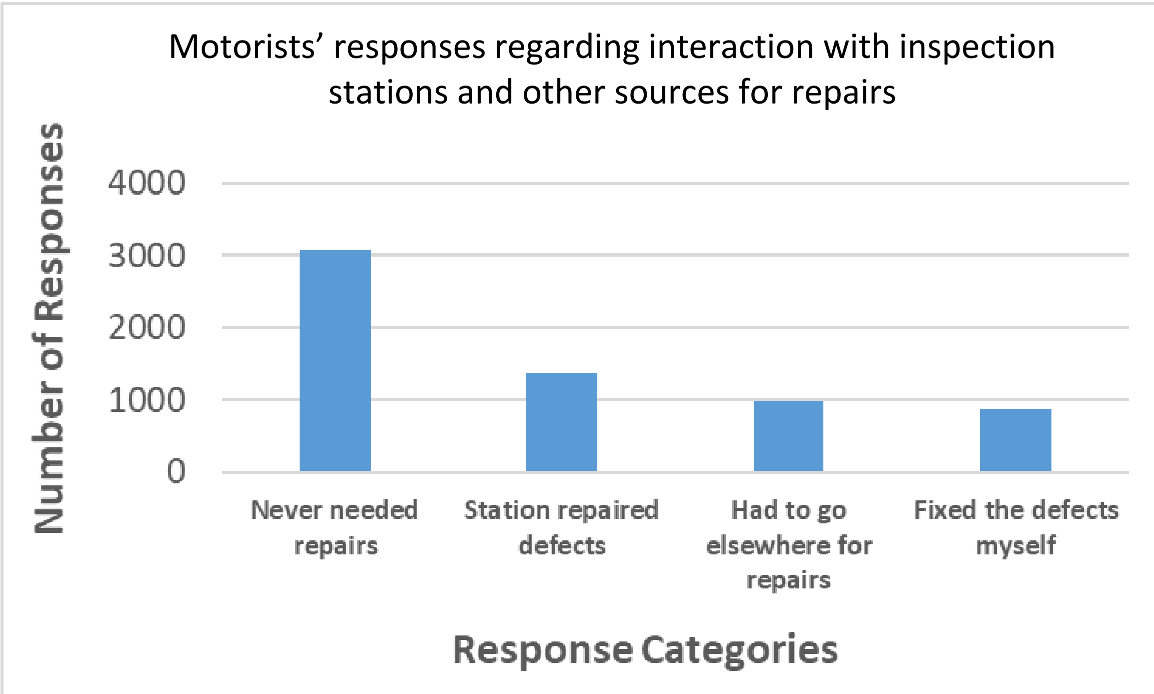


Figure J.8. Responses to the question about interactions with inspection stations or other sources for repairs

Regarding whether vehicle owners think that an inspection takes too much time, the interpretation of the responses varied depending on how the data is presented. Figures J.9–J.13 show these variations.

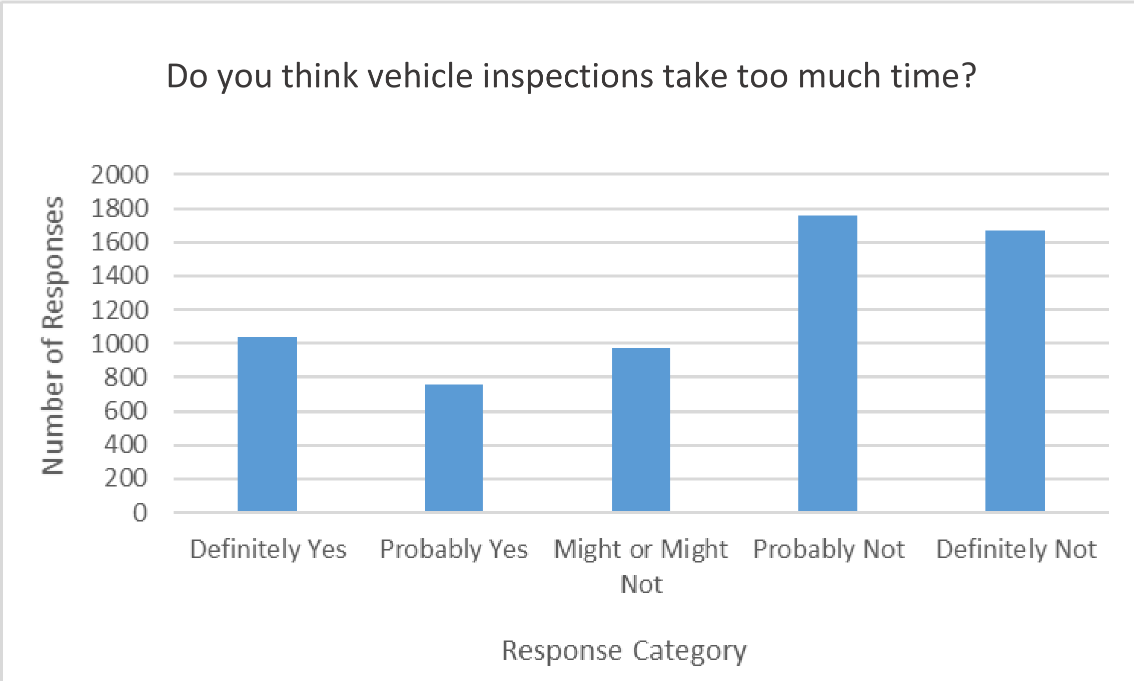


Figure J.9. Responses to the question "Do you think vehicle inspections take too much time?"

Figure J.10 displays respondents who only replied 'Definitely Yes' to the question 'Do you think vehicle inspections take too much time? It is apparent that vehicle owners who have never had to have replacement parts or repairs comprise the majority of individuals who do think inspections take too much time.

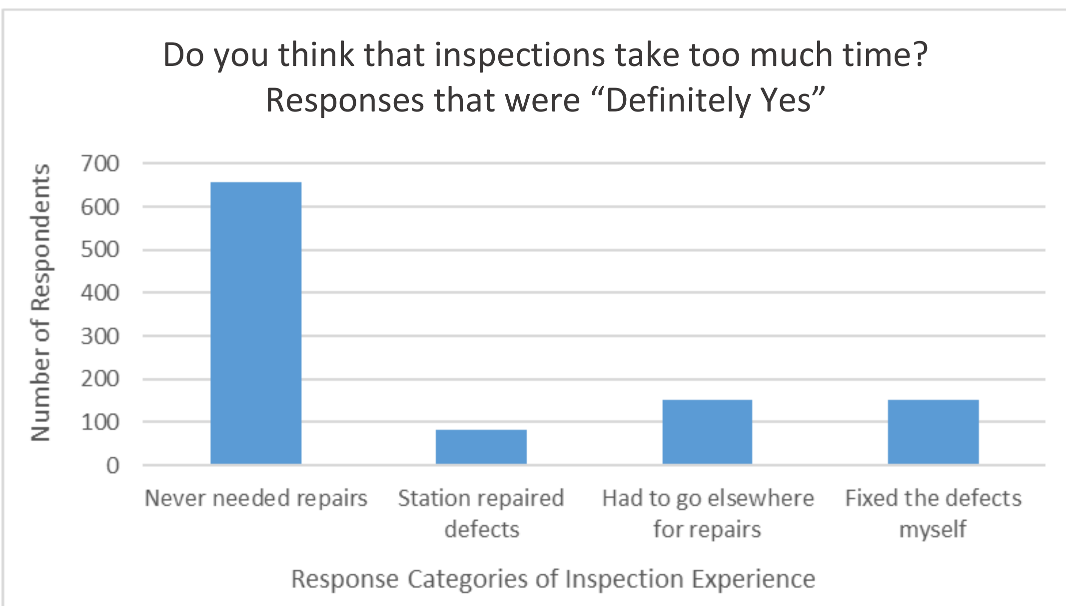


Figure J.10. Responses to the question about whether vehicle inspections take too much time

Figure J.11 shows the response distribution for vehicle owners who required repairs to their vehicle and were able to have the repairs performed at the inspection station.

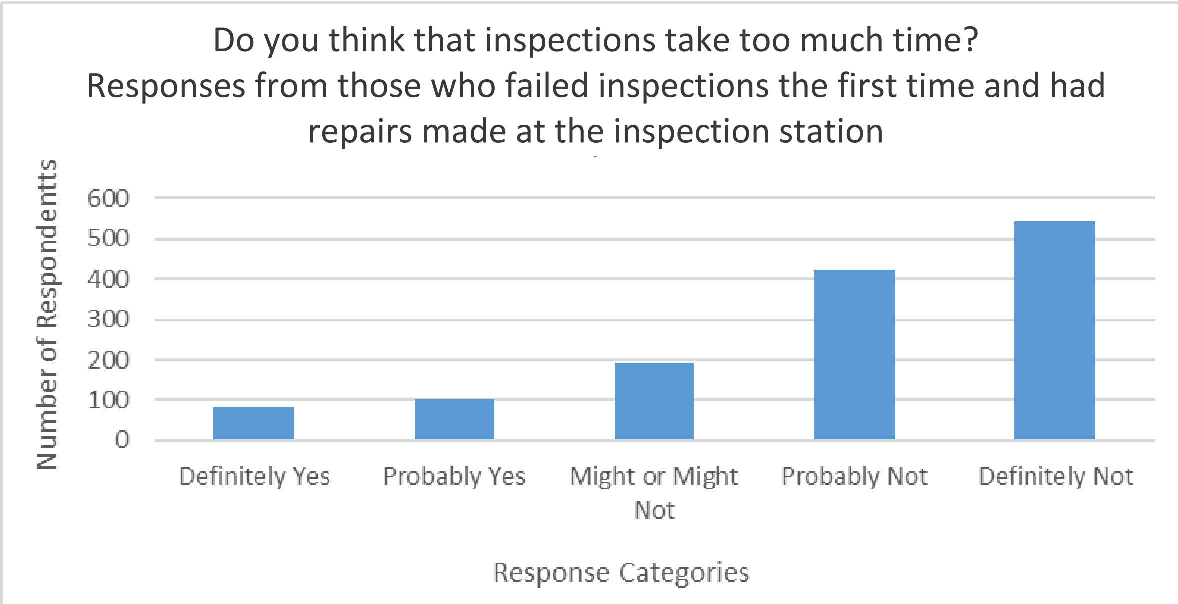


Figure J.11. Number of respondents who failed the inspection but were able to have their vehicle repaired at the inspection station

Figure J.12 shows responses from individuals who failed the inspection first-time and took their vehicle home for repairs before taking it back to the inspection station for a second inspection. The results are similar (Figure J.13) for individuals who failed inspection first-time and had to take their car 'Elsewhere', that is, to another mechanic, tire shop, or repair shop for repairs. This can occur if the inspection station is not equipped to perform the required repair or is out of parts for that particular brand and model of vehicle.

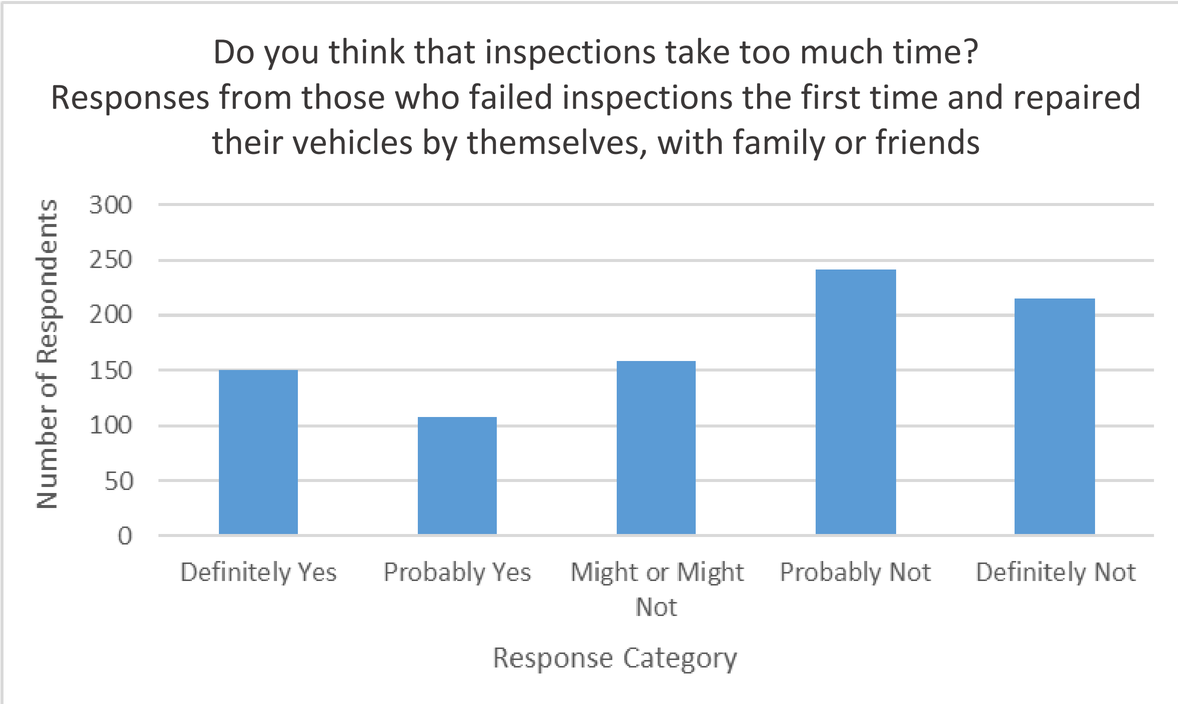


Figure J.12. Number of respondents who failed first-time inspection and took their car home for repairs.

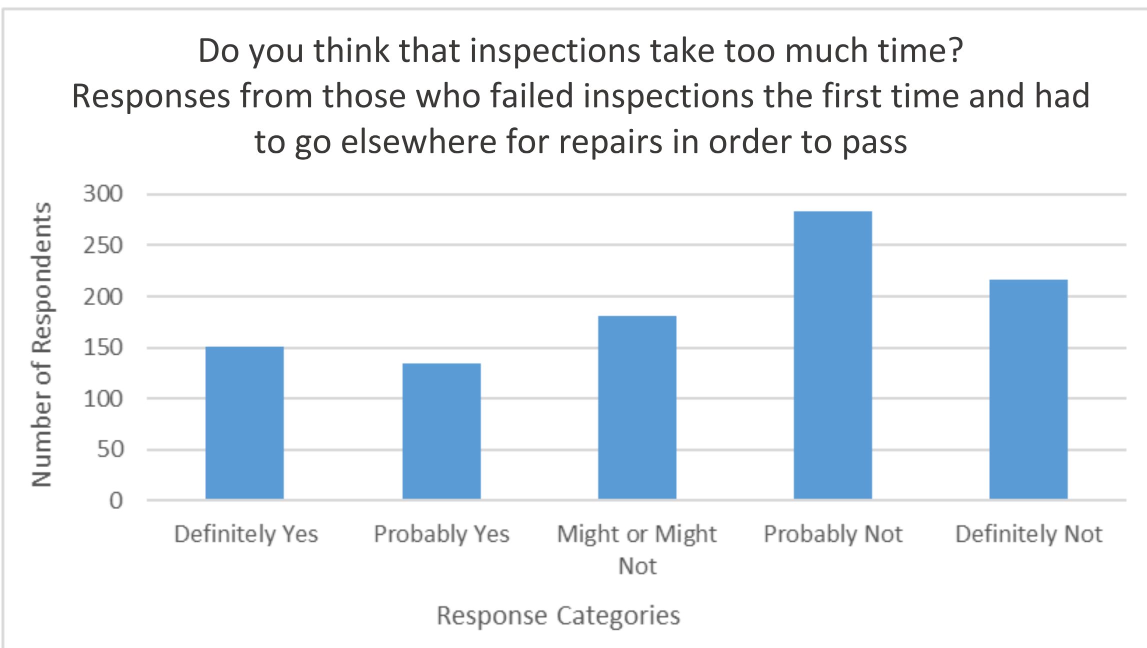
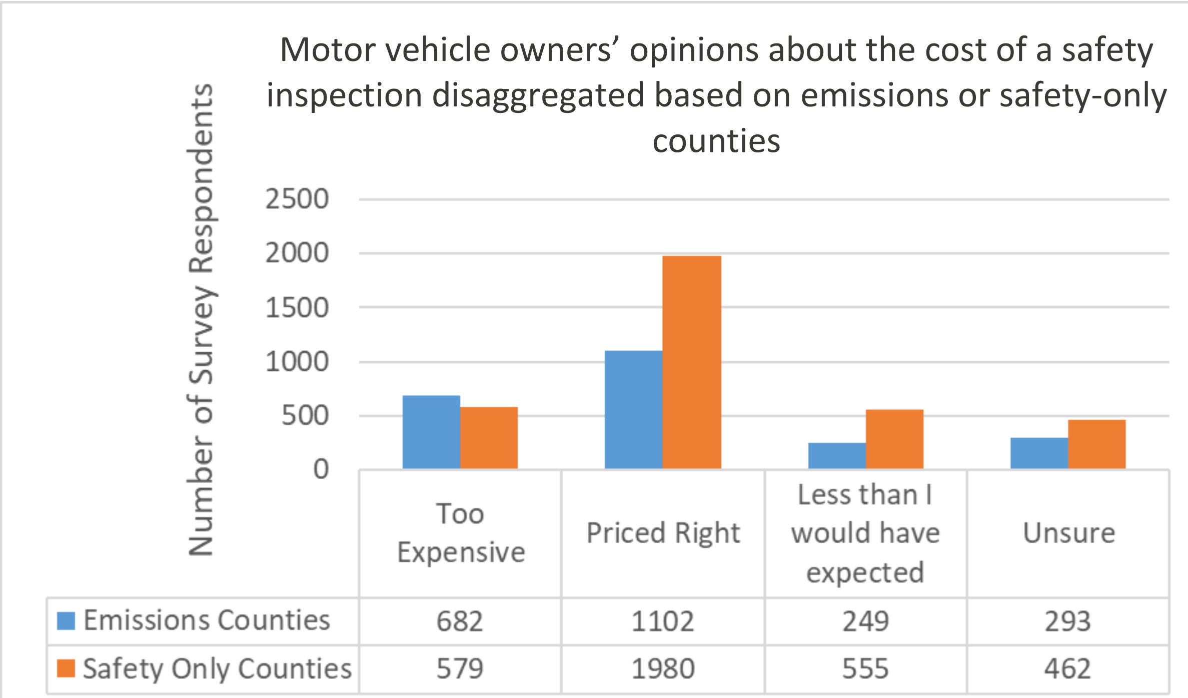


Figure J.13. Number of respondents who failed first-time inspection and took their car elsewhere for repairs

Finally, vehicle owners were asked about the cost of a safety inspection. However, during the workshop discussed in Chapter 5 of the main report, stakeholders pointed out that inspection fees are more expensive in emissions counties than in safety-only counties and that the survey did not clearly explain that the inspection fee only pertained to the $7.00 safety inspection fee, not the emissions and safety inspection fee.

Thus, the graph in Figure J.14 is displayed for informational purposes only and should not be used to arrive at conclusions about vehicle owners' opinions regarding the safety inspection fee.



	Too Expensive	Priced Right	Less than I would have expected	Unsure
Emissions Counties	682	1102	249	293
Safety Only Counties	579	1980	555	462

*Figure J.14. Vehicle owners' opinions about the safety inspection fee***

**The authors note that the survey question did not make clear that this question pertained only to the $7.00 safety inspection fee paid to an inspection station owner for the safety-only portion of a vehicle inspection.

J.4. Details of Method 2 First Time Failure Rate Calculation

In the survey presented at the beginning of this appendix, vehicle owners were asked to indicate the number of times that they had repairs or purchased replacement parts as a result of a safety inspection (Question 11). The answers ranged from zero (vehicle never needed any repairs or replacement parts) to as many as 30 times. The research team realizes that an individual might own more than one car, thus, 10 failed inspections could occur in any combination of years that adds up to 10 or more. However, the team did not know how many vehicles a person owned over the period in which the reported failures occurred. According to FHWA, there were 16,162,382 licensed drivers in Texas in 2016 (FHWA, 2018). Based on the registration data obtained from TxDMV, the total number of registered passenger vehicles (1980 and newer models) in 2016 was 19,640,255. Thus, the team used the average number of vehicles owned in Texas, which is 1.2 ($\frac{19,640,255}{16,162,382} = 1.2\ veh/driver$), to adjust the following calculations (FHWA, 2018). The research team interpreted the number of times as the number of failures because those safety issues would fail a safety inspection unless repaired. In order to obtain the adjusted first time failure rate, the research team:

- established the maximum and minimum analysis periods for each individual who had repairs or purchased replacement parts as a result of a safety inspection;
- calculated all probable unadjusted (without considering the average vehicle ownership rate) first time failure rates for each individual within the minimum and maximum analysis periods;
- summarized and analyzed the statistics of all probable unadjusted first time failure rates; and
- adjusted the first time failure rates by considering the average vehicle ownership rate.

The maximum analysis period is set as 30 years since the maximum reported number of failed inspections by survey respondents was 30 times. The minimum analysis period is determined when the unadjusted failure rate reaches 100%. Therefore, it varies from individual to individual and equals to the number of failed inspections each respondent reported. For example, if the vehicle owner failed three times, the minimum analysis period is three years and the maximum is 30 years. The respondent might fail three times in three years, or he/she might fail three times in four years, or five years … or 30 years. All probable unadjusted first time failure rates are: $3/3 = 100\%$, $3/4 = 75\%$, $3/5 = 60\%$, … $3/28 = 10.7\%$, $3/29 = 10.3\%$, $3/30 = 10\%$. Similarly, if the vehicle owner failed 7 times, then all probable unadjusted first time failure rates are: $7/7 = 100\%$, $7/8 = 87.5\%$, … $7/29 = 24.1\%$, $7/30 = 23.3\%$. In addition, for those who never failed an inspection, all probable unadjusted first time failure rates are: $0/1 = 0\%$, $0/2 = 0\%$, … $0/29 = 0\%$, $0/30 = 0\%$.

The research team calculated all probable unadjusted first time failure rates for each individual. Consequently, a total of 171,932 failure rates were obtained. The histogram and cumulative probability of all probable failure rates were developed. The bin size of the histogram was selected as three percent. The detained histogram bin information and its corresponding cumulative probability are listed in Table J.4.

Table J.4. Detained Histogram Bin Information and Its Corresponding Cumulative Probability

Bin Center	Range	Frequency	Cumulative Probability	Bin Center	Range	Frequency	Cumulative Probability
1.5%	[0%, 3%)	66,570	38.7%	52.5%	[51%, 54%)	101	95.4%
4.5%	[3%, 6%)	21,364	51.2%	55.5%	[54%, 57%)	284	95.5%
7.5%	[6%, 9%)	17,142	61.2%	58.5%	[57%, 60%)	219	95.7%
10.5%	[9%, 12%)	14,182	69.4%	61.5%	[60%, 63%)	810	96.1%
13.5%	[12%, 15%)	9,625	75.0%	64.5%	[63%, 66%)	34	96.2%
16.5%	[15%, 18%)	6,935	79.1%	67.5%	[66%, 69%)	1,452	97.0%
19.5%	[18%, 21%)	6,076	82.6%	70.5%	[69%, 72%)	252	97.2%
22.5%	[21%, 24%)	3,242	84.5%	73.5%	[72%, 75%)	22	97.2%
25.5%	[24%, 27%)	4,008	86.8%	76.5%	[75%, 78%)	619	97.5%
28.5%	[27%, 30%)	2,313	88.2%	79.5%	[78%, 81%)	171	97.6%
31.5%	[30%, 33%)	949	88.7%	82.5%	[81%, 84%)	241	97.8%
34.5%	[33%, 36%)	3,962	91.0%	85.5%	[84%, 87%)	57	97.8%
37.5%	[36%, 39%)	986	91.6%	88.5%	[87%, 90%)	38	97.8%
40.5%	[39%, 42%)	1,664	92.6%	91.5%	[90%, 93%)	58	97.9%
43.5%	[42%, 45%)	765	93.0%	94.5%	[93%, 96%)	20	97.9%
46.5%	[45%, 48%)	339	93.2%	97.5%	[96%, 99%)	1	97.9%
49.5%	[48%, 51%)	3,652	95.3%	100.5%	[99%, 102%)	3,779	100%

Based on Table J.4, the histogram and cumulative probability of all unadjusted first time failure rates are presented in Figure J.15. Recall that in previous survey analyses, there are 2,219 respondents who actually have never had vehicle parts replaced or repairs made. This results in 66,570 ($2,219 \times 30 = 66,570$) probable failure rates of zero percent considering the minimum analysis period is one year and the maximum is 30 years. Therefore, the frequency in the first bin is larger than any other bins, which can be verified by both Table J.4 and Figure J.15. In addition, based on the calculation, the first bin contains only the zero percent failure rates since the next smallest probable failure rate is $1/30 = 3.3\%$. Previous analyses also indicated that 37% had never failed an inspection and 63% had failed an inspection at least once. According to the first bin in Table J.4, using this methodology, the percentage of respondents who have never failed an inspection is 38.7%, which is very close to (slightly higher than) previous analysis results. This is within the 5% error tolerance ($\frac{38.7\% - 37\%}{37\%} = 4.6\% < 5\%$). The rest of bins account for 61.3% of all probable failure rates, which represents the percentage of respondents who has failed an inspection at least once. This is within the 3% error tolerance ($\left|\frac{61.3\% - 63\%}{63\%}\right| = 2.7\% < 3\%$). It can be observed that the results calculated using this method are very close to those obtained from previous analyses.

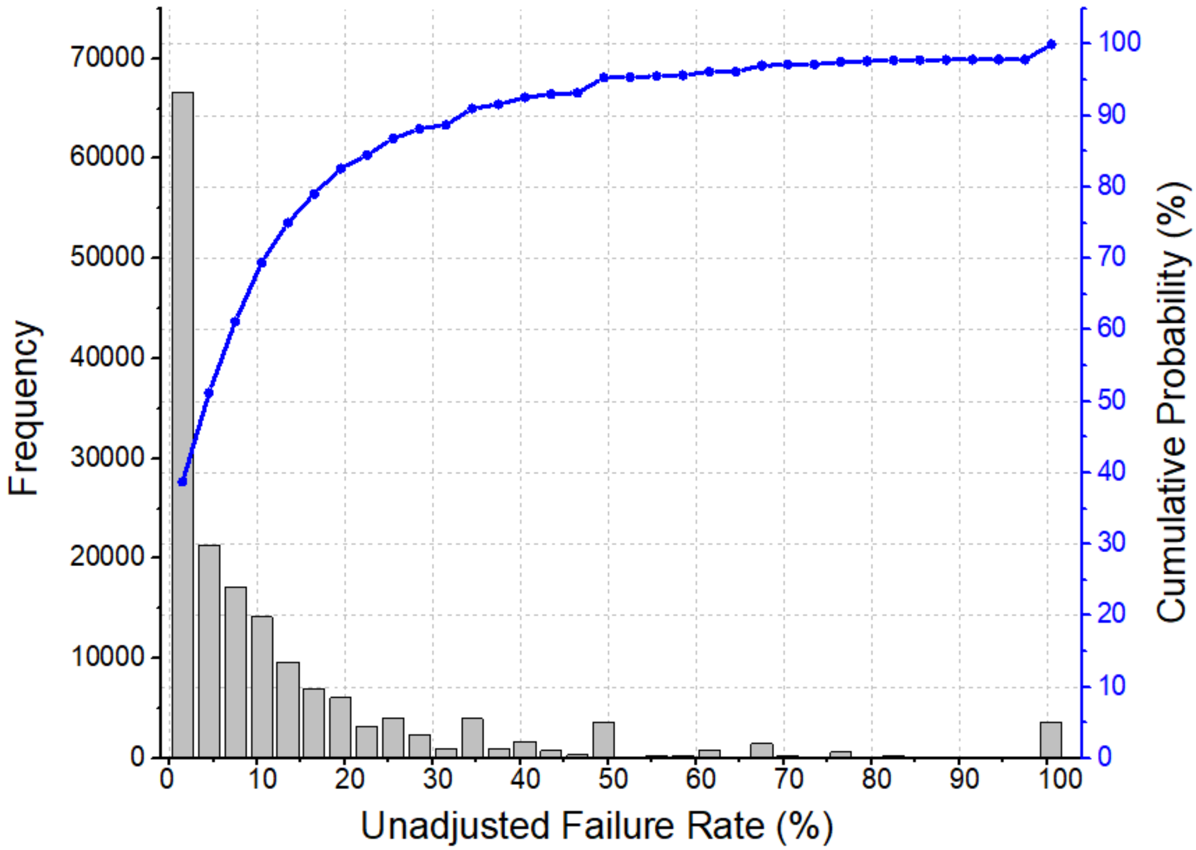


Figure J.15. Histogram and Cumulative Probability of Unadjusted First Time Failure Rate

As can be seen from Figure J.15, the histogram shows an exponential distribution, which is expected because exponential distribution is one of the most common failure distributions in reliability engineering (Ebeling, 2004). Theoretically speaking, failures due to completely random or chance events will follow exponential distribution (Ebeling, 2004). Considering failures of parts on passenger vehicles that are included in the Safety Inspection, the reader can understand that no one can predict when their left headlight, right rear signal light, gas cap seal, and even tire tread depth or tire deterioration will require replacement of these parts. Tires perhaps can be monitored to estimate failure condition using the tread depth bars or a tread depth gauge; however, number of miles driven, driving habits, such as fast acceleration or hard braking can result in different amounts of tire wear between different drivers. Thus, for this analysis the team believes that random inspection component failures are reasonable. The mean value of all the unadjusted first time failure rates is 12.4%. By considering the average vehicle ownership is 1.2 vehicle per licensed driver, the adjusted mean value of the first time failure rate is $\frac{12.4\%}{1.2} = 10.3\%$, which is in the range of 7.5% to 12.5% from 5.5.1 and is substantially higher than the currently captured 2.63%.

Appendix K. Inspection Station Online Survey

CTR developed an online survey to provide information regarding motor vehicle safety inspection station operators' experiences with and opinions about safety inspections. UT is licensed to use the Qualtrics™ online survey and data analysis tools. An online survey was developed by CTR and reviewed by TxDPS study team leaders for suggestions. The online survey is shown below.

-------------------------------------- Inspection Station Survey--

Information only

Texas Motor Vehicle Safety Inspection Program Survey

The State Legislature has required the Texas Department of Public Safety (DPS) to report on the costs and benefits of the passenger vehicle Texas Motor Vehicle Safety Inspection Program. DPS has contracted with the University of Texas at Austin – Center for Transportation Research to assist in preparing this report. Your participation in completing this survey is very important to this report and much appreciated.

If you have any questions regarding this survey, please contact:

Dr. Mike Murphy, P.E.
(512) 232-3134
michael.murphy@engr.utexas.edu

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

Page Break

Q1 Please tell us the location of your station:

- ○ City: (1) ____________________
- ○ County: (2) ____________________

Q2 How will your business be impacted if the passenger Vehicle Safety Inspection Program is eliminated in Texas? Check all that apply.

- ☐ My business would be severely impacted because Vehicle Inspections and related repairs and other products purchases are a major part of my business. (1)
- ☐ My business would be slightly impacted as only a small portion of my business profit is from Vehicle Safety Inspections and related repairs. (2)
- ☐ My business won't be really impacted since we don't get much business from conducting Vehicle Safety Inspections anyway (4)
- ☐ I'm really not sure how my business would be impacted. (6)

Q3 My station has the following Endorsements. Check all that apply

- ☐ 1Y - may inspect any vehicle requiring a one-year inspection (1)
- ☐ 2Y - may inspect any vehicle requiring a two-year inspection (2)
- ☐ CW - may inspect any vehicle requiring a commercial inspection (3)
- ☐ CT - may inspect any vehicle requiring a commercial trailer inspection (4)
- ☐ TL - may inspect any vehicle requiring a trailer inspection (5)
- ☐ MC - may inspect any vehicle requiring a motorcycle inspection (6)

Q4 We don't do repairs or sell replacement parts if needed to pass the Vehicle Safety Inspection. If the vehicle fails the inspection the owner must go elsewhere to have repairs made.

- ○ Yes (4)
- ○ No (5)

Q5 We can make small repairs and sell some replacement parts if needed to pass the Inspection. However, the customer may need to go to another business if the repairs are more complex.

- ○ Yes (1)
- ○ No (2)

Q6 We can make any type of repairs or obtain/sell replacement parts needed to pass the Vehicle Safety Inspection.

- ○ Yes (5)
- ○ No (6)

Q7 How many years has your station provided the Vehicle Safety Inspection service?

- ○ Less than 1 year (1)
- ○ 1 to 3 years (2)
- ○ 3 to 5 years (3)
- ○ 5 to 7 years (4)
- ○ 7 to 10 years (5)
- ○ 10 to 15 years (6)
- ○ 15 to 20 years (7)
- ○ 20 to 30 years (8)
- ○ greater than 30 years (9)

Q8 On average how many certified full-time employees (40 or more hours per week) do you have who can perform Vehicle Safety Inspections as part of their duties?

- 0 full-time certified employees (1)
- 1 - 2 full-time certified employees (2)
- 3 - 4 full-time certified employees (3)
- 5 - 7 full-time certified employees (4)
- 8 - 10 full-time certified employees (5)
- 11 - 15 full-time certified employees (6)
- 16 - 20 full-time certified employees (7)
- 21 - 25 full-time certified employees (8)
- greater than 25 full-time certified employees (9)

Q9 On average how many certified part-time employees (less than 40 hours per week) do you have who can perform Vehicle Safety Inspections?

- 0 part-time certified employees (1)
- 1 - 2 part-time certified employees (2)
- 3 - 4 part-time certified employees (3)
- 5 - 7 part-time certified employees (4)
- 8 - 10 part-time certified employees (5)
- 11 - 15 part-time certified employees (6)
- 16 - 20 part-time certified employees (7)
- 21 - 25 part-time certified employees (8)
- greater than 25 part-time certified employees (9)

Q10 On average, how many vehicles does your station inspect per week?

- ○ 1 - 5 vehicles (1)
- ○ 6 - 10 vehicles (2)
- ○ 11 - 20 vehicles (3)
- ○ 21 - 30 vehicles (4)
- ○ 31 - 40 vehicles (5)
- ○ 41 - 50 vehicles (6)
- ○ 51 - 75 vehicles (7)
- ○ 76 - 100 vehicles (8)
- ○ 101 - 150 vehicles (9)
- ○ greater than 150 vehicles (10)

Q11 On an average weekday, how many vehicles does your station fail due to one or more safety issues when performing the first inspection?

- ○ no vehicles (1)
- ○ 1 - 2 vehicles (2)
- ○ 3 - 4 vehicles (3)
- ○ 5 - 10 vehicles (4)
- ○ 11 - 15 vehicles (5)
- ○ 16 - 20 vehicles (6)
- ○ 21 - 25 vehicles (7)
- ○ 26 - 30 vehicles (8)
- ○ 31 - 40 vehicles (9)
- ○ 41 - 50 vehicles (10)
- ○ Greater than 50 vehicles (11)

Q12 On average, how many vehicles per week fail the Safety Inspection and must go to another business to have repairs or replacement parts done before they can come back to your station to pass inspection?

- 0 vehicles (1)
- 1 - 2 vehicles (2)
- 3 - 5 vehicles (3)
- 6 - 10 vehicles (4)
- 11 - 15 vehicles (5)
- 16 - 20 vehicles (6)
- 21 - 25 vehicles (7)
- 26 - 30 vehicles (8)
- 31 - 40 vehicles (9)
- 41 - 50 vehicles (10)
- Greater than 50 vehicles (11)

Q13 On average, how long does it usually take for one vehicle to be inspected for safety (no emissions testing) if no repairs or replacement parts are needed?

- 30 minutes or less (1)
- between 31 minutes and 45 minutes (2)
- between 46 minutes and 1 hour (3)
- between 1 hour and 1 hour-30 minutes (4)
- between 1 hour-30 minutes and 2 hours (5)
- greater than 2 hours (6)

Q14 On average, how long does it usually take for one vehicle to be inspected for safety if repairs or replacement parts are needed and are performed at your station?

- ○ 30 minutes or less (1)
- ○ between 31 minutes and 45 minutes (2)
- ○ between 36 minutes and 1 hour (3)
- ○ between 1 hour and 1 hour-30 minutes (4)
- ○ between 1 hour-30 minutes and 2 hours (5)
- ○ between 2 hours and 2 hours-30 minutes (6)
- ○ between 2 hours-30 minutes and 3 hours (7)
- ○ greater than 3 hours (8)

Q15 Please click each of the types of repairs or replacement parts you typically perform so that a vehicle with a safety issue is able to pass inspection.

- ☐ Replace worn wiper blades (1)
- ☐ Replace head light(s) (2)
- ☐ Replace tail stop light(s) (3)
- ☐ Replace turning signal light(s) (4)
- ☐ Repair a tire with an air leak (5)
- ☐ Replace one or more slick tire(s) that are below legal tread depth (6)
- ☐ Replace brake pads that are below legal standards (7)
- ☐ Perform brake adjustments (8)
- ☐ Perform repairs or adjustment to the emergency brake (9)
- ☐ Repair cracks or damaged areas to a windshield (10)
- ☐ Repair a horn that does not work (11)
- ☐ Repair a steering mechanism problem (12)
- ☐ Replace a rear view mirror (13)
- ☐ Adjust or replace seat belts (14)
- ☐ Replace or repair the high beam indicator (15)
- ☐ Repair or replace the license plate light (16)
- ☐ Repair or replace red rear reflectors (17)
- ☐ Repair gas cap or replace missing gas cap (18)
- ☐ Replace window tint that does not meet safety criteria (19)
- ☐ Replace or repair wheel rims (20)

Q16 If your station also does vehicle emissions testing, how long does the vehicle emissions test take?

- ○ Less than 30 minutes (1)
- ○ 31 minutes - 1 hour (2)
- ○ greater than 1 hour (3)

Q17 Do you think that the Vehicle Safety Inspection Program improves highway safety in Texas?

- ○ Definitely yes (1)
- ○ Probably yes (2)
- ○ Might or might not (3)
- ○ Probably not (4)
- ○ Definitely not (5)

Q18 What's your opinion about the cost of a Motor Vehicle Safety Inspection:

- ○ Too high (1)
- ○ High (2)
- ○ Priced right (3)
- ○ Low (4)
- ○ Too low (5)

Q19 If you know a vehicle is going to fail the inspection, what would you do? Check all that apply.

- ▢ Before the inspection, you see that there is a safety problem and tell the vehicle owner to have the problem fixed then the inspection will be performed. (1)
- ▢ During the inspection, you tell the vehicle owner that there is a safety problem(s) which your station can fix, after the repair(s) or part(s) replacement(s) are performed the vehicle will pass the inspection. (2)
- ▢ Fail the vehicle during the inspection then tell the vehicle owner to have the problem fixed and bring their vehicle back. Afterward you will perform a 2nd inspection after the repairs are performed (3)

Q20 Please write additional comments you may have about the Texas Motor Vehicle Safety Inspection Program and its effect on Highway Safety in Texas.

____

End of Block: Default Question Block

A list of inspection station email addresses was obtained from TxDPS to distribute a link to the online survey to each station. A total of 6,545 stations were contacted. Of those stations contacted, 1,823 survey responses were received, of which 1,582 surveys responded to 100% of the survey questions. The number of 100% completed surveys represents approximately 86.8% of all survey responses received and 24.2% of stations contacted by email. During the course of the study period reminder emails were distributed by both TxDPS (2) and CTR (3) to encourage more stations to complete the survey. Each of these reminders resulted in additional survey responses.

The number of completed survey responses received included 757 from stations that perform only safety inspections and 805 survey responses from stations that perform both emissions and safety inspections. These sample sizes provide a sufficient number of survey to make statistically valid statements about Texas safety inspection stations statewide at the 95% confidence interval, +/- 3% error.

In addition, enough surveys were obtained to make statistically valid statements about individual categories of stations such as 'emissions and safety inspection stations' in comparison to 'safety-only stations', 'urban or rural county locations', and 'distributions of responses for small, intermediate and large station operations' at the 95% confidence interval +/- 4% error.

K.1. Economic Impact on Inspection Stations if Safety Inspections Are Eliminated

Figure K.1 shows the number inspection stations categorized by the number of vehicles that are inspected per week (on average). It is important to note that these values are calculated average numbers and that inspection station owners pointed out during the Workshop that many vehicle owners have their cars inspected either at the end or beginning of the month. It is conjectured that these individuals choose to have their cars inspected near the end of the month since payday occurs at this time for many individuals. Thus, weekly numbers of inspections might vary significantly over the course of a month.

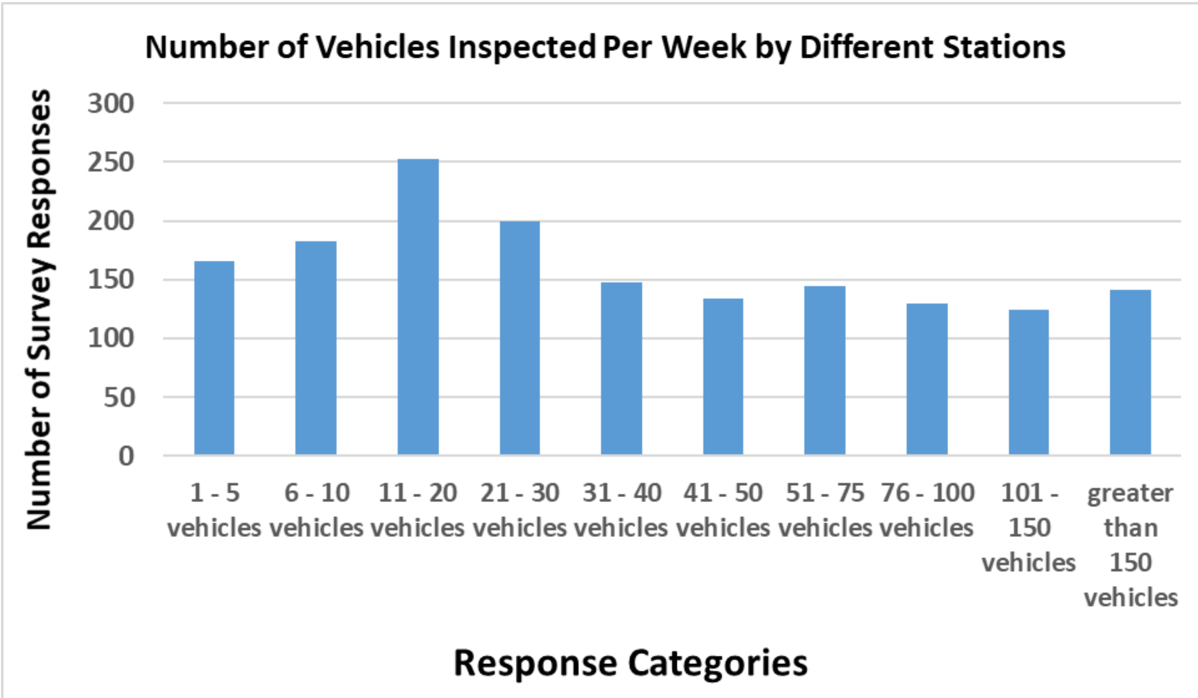


Figure K.1. Number of inspection stations categorized by number of vehicles inspected per week

Figure K.2 shows the inspection station responses to this question "How will your business be impacted if safety inspections for passenger vehicles in Texas are eliminated?"

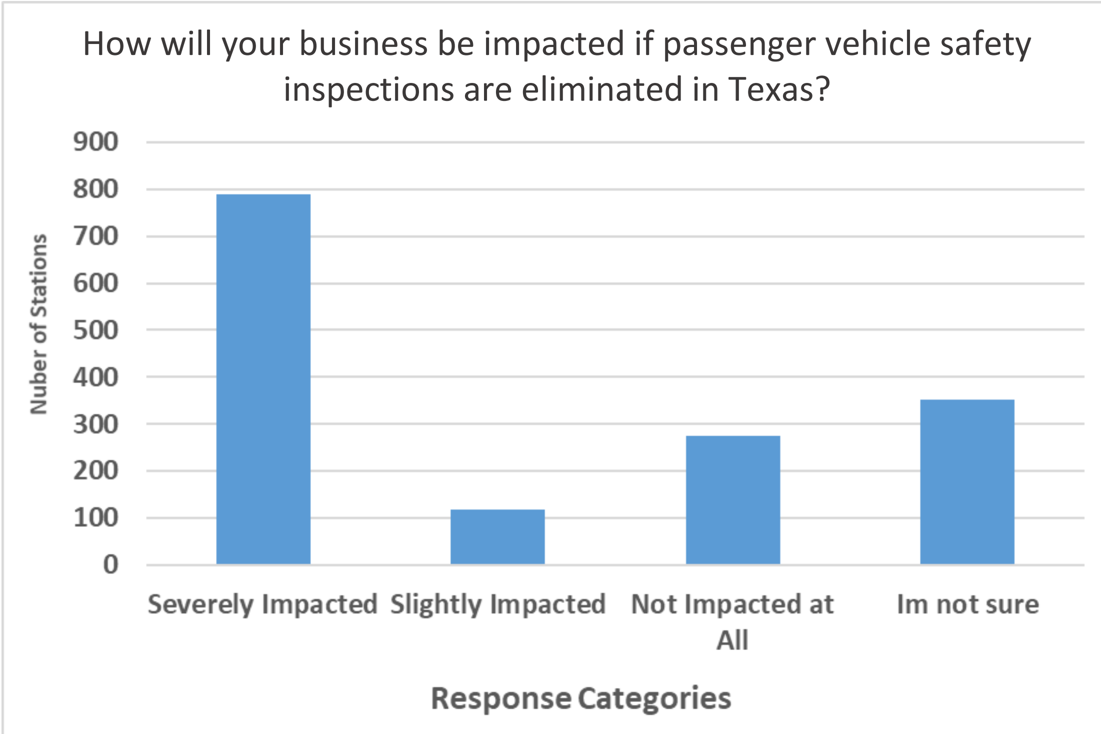


Figure K.2. Responses about potential impact to vehicle inspection stations if the safety inspection for PVs is eliminated

Approximately 50.5% (790) of station operators surveyed indicated that their business would be severely impacted; 7.8% (119) would be slightly impacted, 17.9% (274) would not be impacted at all, and 22.9% (351) were unsure how their business would be impacted.

Figure K.3 shows the distribution of years in business for the survey respondents.

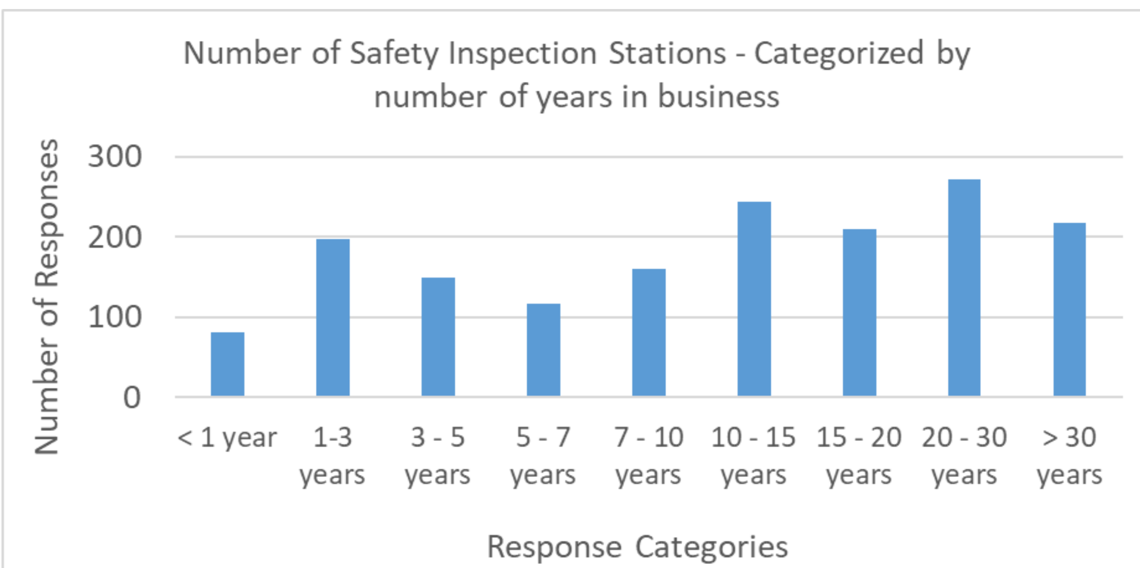


Figure K.3. Inspection stations categorized by number of years in business

Approximately 57.3% of inspection businesses have been in operation 10 or more years. Approximately 16.8% of inspection businesses have been in operation three or less years.

Figure K.4 shows the number of full-time certified employees. The estimated total number of certified inspection technicians is approximately 5,439 individuals.

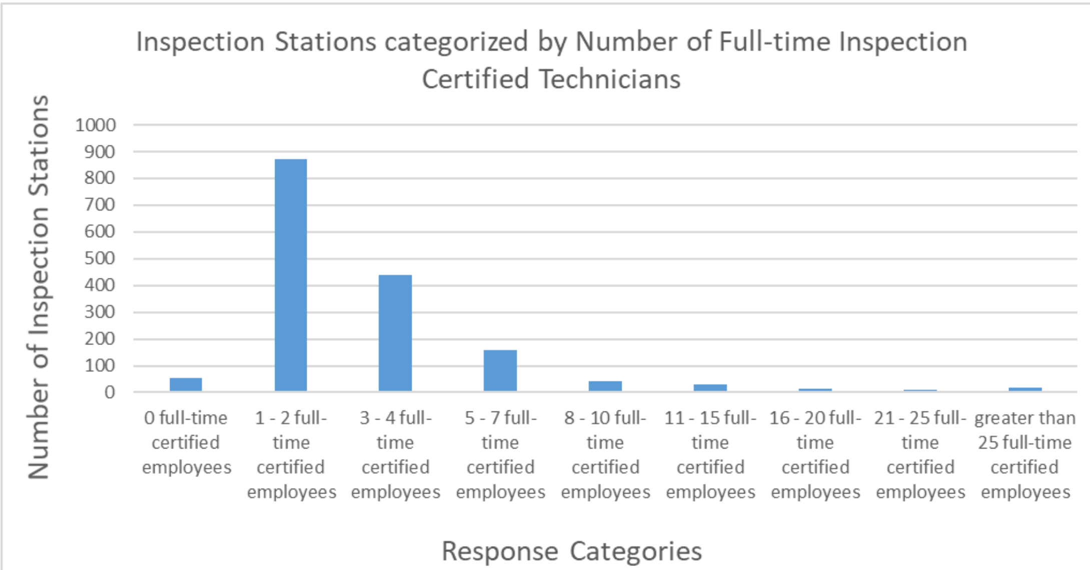


Figure K.4. Inspection stations categorized by number of full-time certified inspection technicians

Figure K.5 shows the number inspection stations with from zero to more than five part-time certified inspection technicians on staff. Based on this information, approximately 983 part-time certified inspection technicians are on staff with the stations surveyed. If each of these technicians work half-time, this is the equivalent of 482 additional full-time employees, which when added to the previously calculated number of full-time inspection technicians (5,439) results in the equivalent of 5,921 full-time employees. Using information about the number of inspection stations that responded to the survey, the percentage of stations that responded to this question, and the numbers of full- and part-time employees, this results in an estimated 45,300 employees for all inspection stations statewide (approximately 12,500). This number closely agrees with the number of employees mentioned in Chapter 2.

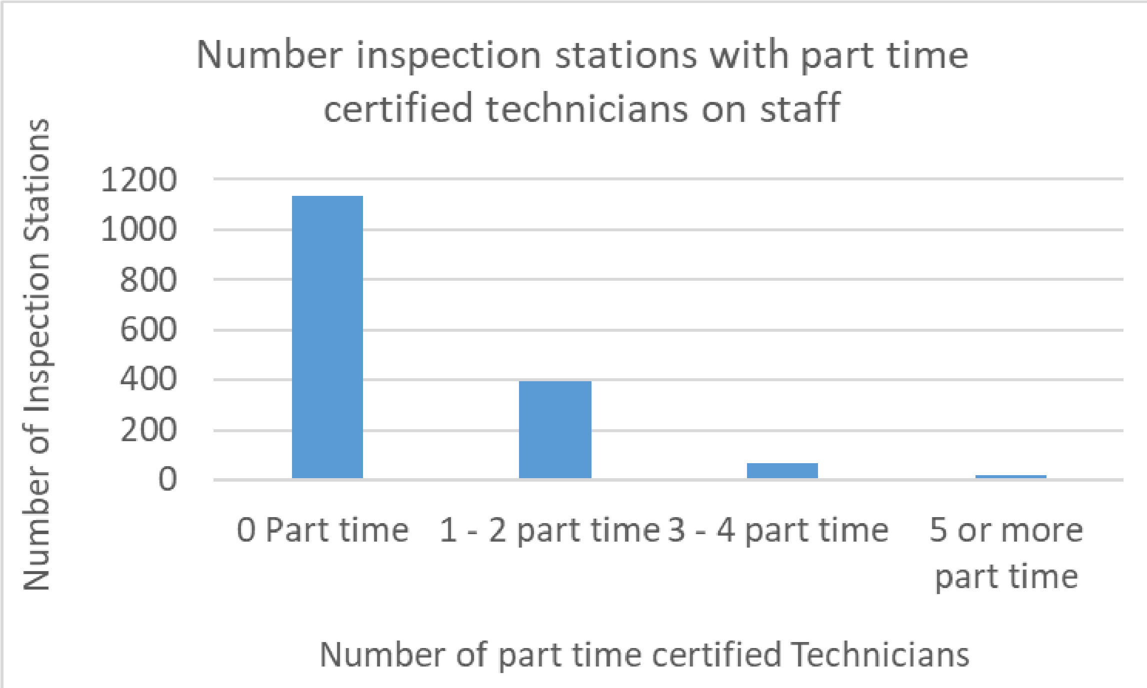


Figure K.5. Number of part-time certified inspection technicians reported by the survey respondents

Figure K.6 shows responses to this question: "Do you think the vehicle safety inspection program improves highway safety in Texas?" Approximately 82.5% of survey respondents indicated 'Definitely' or 'Probably Yes', 7.8% indicated that safety inspections 'Might or Might Not Improve Highway Safety', and 9.6% of stations indicated that safety inspections 'Probably Not' or 'Definitely Not' improved safety.

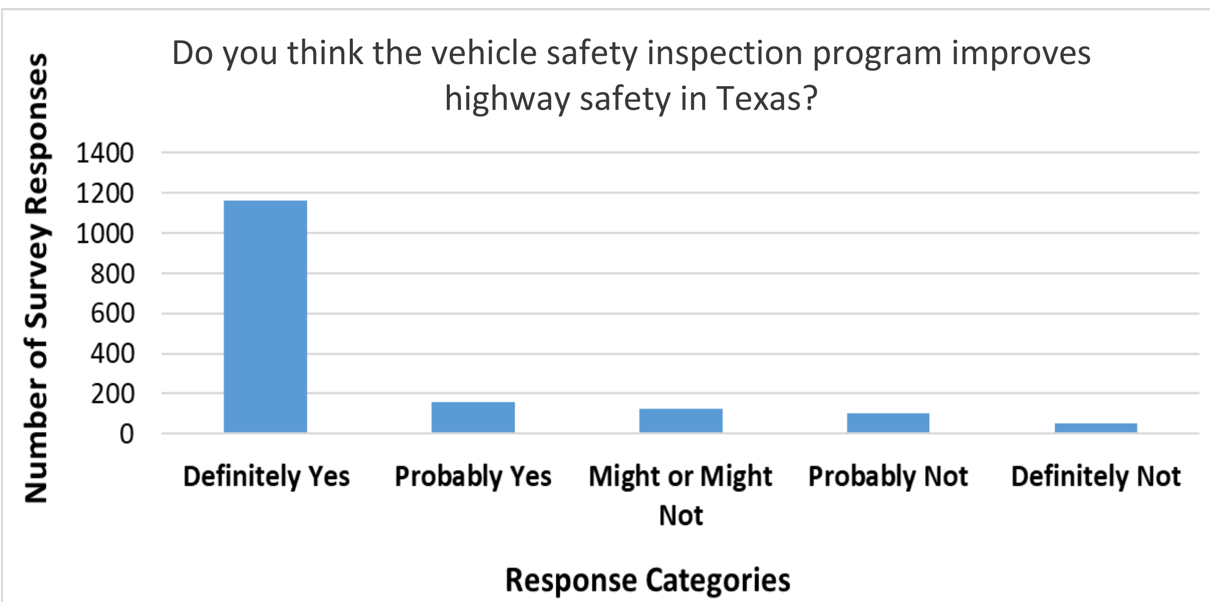


Figure K.6. Responses about whether vehicle inspections benefit highway safety in Texas

The majority of inspection station operators who responded that that safety inspections do benefit highway safety pointed out that low-income individuals or families may not be able to perform maintenance of their vehicles as needed. In other cases, elderly drivers may not be aware of maintenance issues and appreciate having a safety inspection to ensure that defects are addressed and their vehicles are in compliance.

An extremely important point that should be emphasized is that safety inspections not only benefit the vehicle owner, but also benefit all other drivers on the road. Crashes involving vehicles with defects often occur with another vehicle that does not have defects. In some cases, fatalities or serious injuries that result from the crash occur in the vehicle without defects. Thus, everyone benefits when all vehicles on the road are in compliance with safety inspection requirements.

Some station owners who responded that they ‘Probably’ or ‘Definitely [did] Not’ think safety inspections support safety took the time to comment that this sentiment reflects their opinions about the state rules and the inspection fee that affects their business operations, rather than directly about how safety inspections affect highway safety.

One inspection station owner commented that he/she sees vehicles with defects driving on the road, despite the Inspection Program’s existence. This could be due, in part, to safety inspections occurring every 12 months. A vehicle that barely passes inspection can be out of compliance within a few months. Thus, there are vehicles on the highway that have passed the annual safety inspection within the past year, but now, due to continued wear of tires, brakes, and other components, would currently not pass an inspection. In addition, as pointed out by the station operator, there are businesses in Texas that rent tires to customers. The study team’s examination of crash reports found a law enforcement officer’s statement that the vehicle owner had rented a tire that was not properly mounted and came off the vehicle, causing a crash. It is feasible that vehicle owners who do not have adequate resources to buy one or more new tires might choose to rent tires to pass an inspection, in order to continue driving their vehicle. In that case, the vehicle owner might also choose to return the rental tires and remount their defective or slick tires.

Figures K.1 through K.6 provide additional insights about whether safety inspections improve highway safety in Texas. Figure K.7 shifts the focus to perceived impact of discontinuing the Inspection Program. This graph depicts the number of stations that indicated they would not be impacted at all if safety inspections were eliminated, categorized by number of vehicles inspected per week.

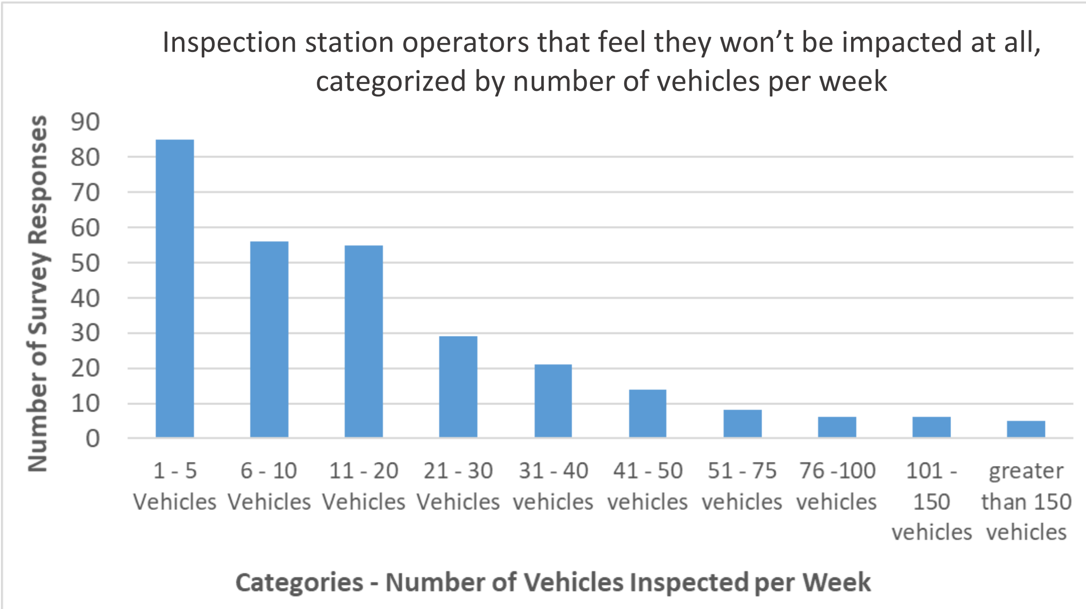


Figure K.7. Number of stations that would not be impacted categorized by number of vehicles inspected per week

Of the 285 stations who indicated they would not be impacted at all, approximately 33% inspect from one to five vehicles per week and approximately 79% inspect 30 or fewer vehicles per week.

Approximately 30% of stations that inspect 30 or fewer vehicles per week indicated their business *would* be severely impacted. In addition, of the 152 inspection stations that indicated either 'Probably' or 'Definitely Not' regarding whether safety inspections improved safety, 71% inspect 30 or fewer vehicles per week.

However, it bears repeating that the majority of comments from individuals who responded either 'Probably' or 'Definitely Not' regarding whether safety inspections improved highway safety are individuals who focused on the operational aspects of the safety inspection program and their frustration with the $7.00 safety inspection fee as limiting factors in providing an effective safety inspection.

These comments may beg the question of why these stations remain in business if they cannot make a profit performing safety inspections. This issue was discussed during the workshop and during stakeholder interviews that involved experienced inspection station operators. Most safety inspection stations offer other services to their loyal and routine customers, such as major repairs, oil changes, and other routine maintenance. The expectation of these loyal customers is to also have their car inspected by the same business that performs repairs and maintenance on their vehicles during the year. Thus, as a service to their customer base, safety inspections are performed, often at a profit loss.

In Appendix J, it was shown that vehicle owners stated that approximately 25% of the time, inspection station operators notice a defect and tell the driver to have the defect fixed, then come back to the station for an inspection.

The safety inspection station survey had a similar question, which asked, "If you know a vehicle will fail the inspection, what would you do? (Check all options that apply)."

The option to check all applicable options was offered because inspection station operators might respond differently depending on the circumstances, when first viewing a vehicle to be inspected. As a result some station operators checked more than one option, creating the need to prorate the responses when more than one response was given.

Q19 If you know a vehicle is going to fail the inspection, what would you do? Check all that apply.

☐ Before the inspection, you see that there is a safety problem and tell the vehicle owner to have the problem fixed then the inspection will be performed. (1) **690 Responses (29.7%)**

☐ During the inspection, you tell the vehicle owner that there is a safety problem(s) which your station can fix, after the repair(s) or part(s) replacement(s) are performed the vehicle will pass the inspection. (2) **947 Responses (40.7%)**

☐ Fail the vehicle during the inspection then tell the vehicle owner to have the problem fixed and bring their vehicle back. Afterward you will perform a 2nd inspection after the repairs are performed. (3) **688 Responses (29.6%)**

Question 19 has been underscored since these responses apply only to vehicles that the inspector knows will fail the inspection and thus do not apply to vehicles that pass inspection. It should be further noted that survey respondents could check more than one response if each applied to their business practices. Thus, though some inspection station operators checked only one option, others checked two or three options. This required prorating the multiple responses by multiplying 2 responses by 0.5 and 3 responses by .333, considering that the actual percentage of time that one or the other action would be taken if two (or three) actions were checked.

Based on this analysis, the adjusted percentages for each action are given below.

☐ Before the inspection, you see that there is a safety problem and tell the vehicle owner to have the problem fixed then the inspection will be performed. (1) **(23%) adjusted to 25%**

☐ During the inspection, you tell the vehicle owner that there is a safety problem(s) which your station can fix, after the repair(s) or part(s) replacement(s) are performed the vehicle will pass the inspection. (2) **(42%)**

☐ Fail the vehicle during the inspection then tell the vehicle owner to have the problem fixed and bring their vehicle back. Afterward you will perform a 2nd inspection after the repairs are performed. (3) **(33%)**

Thus station operators indicated that they tell a vehicle owner to have a defect repaired, then come back for the inspection, about 23% of the time, compared to 25% based on vehicle owner responses. These values are within the +/- 3% error band for these analyses and it can be said that in either case about 25% of the time the vehicle owners are told to have a defect repaired before the inspection is performed. Again, this results in an under-counting of first-time failures.

In Appendix J, it was determined that approximately 37% of vehicles have not needed parts or repairs; therefore, it follows that 63% of vehicles have failed an inspection at least once and have required parts or repairs.

Question 19 applies only to vehicles that the inspection station operator knows will fail the inspection. Thus, the following case study of 1,000 vehicles illustrates the most likely failure responses:

Never needed parts or repairs = 1,000 x 37% = **370** vehicles. Thus, the remaining 63% of vehicles **(**630 vehicles) fail inspection in one of the following three manners:

1. Before the inspection, you see that there is a safety problem and tell the vehicle owner to have the problem fixed then the inspection will be performed. 630 vehicles x 25% = **157 vehicles.**

2. During the inspection, you tell the vehicle owner that there is a safety problem that your station can fix, and after the repair or part replacement is performed, the vehicle will pass the inspection. 630 vehicles x 42% = **265 vehicles**

3. Fail the vehicle during the inspection, then tell the vehicle owner to have the problem fixed and bring their vehicle back. You will perform a second inspection after the repairs are performed. 630 vehicles x 33% = **208 vehicles**

Thus, of every 1,000 vehicles inspected, it is estimated that the station operator performs repairs on approximately 265 vehicles. The remaining vehicles either pass inspection with no need for repairs or fail inspection but are sent elsewhere for parts before the final inspection is performed.

Appendix L. Supplementary Materials for Houston Taxi and Limousine Inspection Data Evaluation

This appendix provides additional detailed information regarding Houston taxi and limousine inspection data evaluation and analysis, which is presented in Chapter 6.

Houston ran a mandatory inspection program for the city's taxis and limousines from 2011 through 2016. This inspection was separate from and in addition to that of the state Inspection Program. The City developed its own inspection standards that examined about 77 items, which exceeds the number of items inspected during mandatory state inspection. The CTR team obtained inspection records for this program from a Houston-based inspection station (HAF, Inc.) with whom the City had contracted to provide this service.

L.1. Inspection Data Processing

The Houston taxi and limousine inspection records were obtained as four boxes of paper copies. In order to study and analyze the inspection reports, CTR developed an Excel database to store all the information found on the detailed inspection result sheet, including first inspection date, cost of the inspection, vehicle year, vehicle make and model, mileage, first inspection result, detailed failure reasons, number of defective items, re-inspection date and result, etc. In the report, the inspector wrote the detailed reason why the vehicle failed the first inspection and whether the vehicle was re-inspected. Figure L.1 shows one example of detailed inspection result sheet, where all the corresponding information can be found. Table L.1 lists the items that were inspected under the program.

In total, about 3,000 inspection records were obtained. The study team randomly selected 714 records for processing 714. For our analysis, the study team calculated the first-time failure rate, the vehicle age when the vehicle was inspected, and the days between the first and second inspections. Since the taxis and limousines followed the same inspection standard, the study team combined taxi and limousine inspection results for analysis purposes.

CITY OF HOUSTON VEHICLE FOR HIRE INSPECTION FORM

Company Name: [redacted] Cab Number: ______ License Plate: ______

Individual Driving Vehicle: ______

Make: ______ Model: ______ Engine: ______ Mileage: ______

☑ OK - Not Applicable X Needs repair ⊗ Repair Complete

VEHICLE OVERVIEW INSPECTION	VEHICLE EXTERIOR INSPECTION	WHEELCHAIR ACCESSIBLE VEHICLES
Horn	Cleanliness	Operating Condition
Windshield Wipers	Body Condition	Control Pendant
Mirrors	Bumper Condition	Electrical Wiring
Steering	Trunk/Luggage Compartment	Vehicle interlock
Seat Belts	Weather Stripping	Hand Rails
Brakes	Wheel and Wheel Covers	Lift Mounts and support points
Wheel Assembly	Back up Lights	Main Lift Pivot
Exhaust System	Suspension	Platform and attachment points
Exhaust Emission System	Shock Absorbers	Inner Roll-stop
Headlight – Hi-beam Indicator	Engine	Platform Roll-stop
Tail Lamps	Oil Leaks	Hydraulic system
Stop Lamps	Battery and Battery System	All Moving Parts – Lubricated
License Plate Lamp	Electrical System	Test Battery
Rear Red Reflectors	Engine Cooling System	Battery Cables and Connections
Turn Signal Lamps	Belts	Manual Backup Systems
Head Lamps	Fuel System	Test Jump/Transfer Seat
Emergency Flashers	Hood Mechanisms	Wheelchair tie downs
Windshield	Transmission	
Frame	Differential	
	Driveshaft/Drive Axle Shafts	
VEHICLE INTERIOR INSPECTION		
Climate Control (A/C and Heat)	**ADDITIONAL REQUIREMENTS**	TPMS
Air Bags	State Inspection – Current	
Instrumentation	State Registration – Current	2/19 **Tires**
Doors/Trim/Armrest/Latch Assemblies		Tread Good
Foot Pedal Pads	**TAXICAB SPECIFIC: (IF EQUIPPED)**	Left Front 7/32 Psi 33
Floor Coverings		
Headliner and Sun Visor	Communication Equipment	Right Front 6/32 Psi 35
Interior Lighting	Surveillance Equipment	
Windshield/Windows/Mirrors		Left Rear 6/32 Psi 34
Seats		
Odors		Right Rear 6/32 Psi 30

NOTES: Tire pressure warning Lamp is on, Check engine lamp is on, 1 A/C Actuator is Noisey at Times Both License plate Lamps on Trap. wiper blades are worn out R/Front Door will not open, Left Front window will not open Hood prop rod is missing Grill and Bumper covers are Very loose, 2 Trim panels missing on Front Bumper, Front sway bar bushings are worn, wheel covers, R/Front outer Axle Boot Torn

This vehicle FAILED (Passed/Failed).

If the vehicle has failed, a copy of the inspection has been provided to the company/individual to notify them of what items are in need of repair.

Re-Inspection Date: 5-7-18 Passed/Failed: Passed 1:45

Technician: [redacted] Job No.: ______ Date: 4-25-18

Form Provided by the City of Houston 08/11

Figure L.1. An example of a Houston Taxi and Limousine Inspection Report

Table L.1. Detailed inspection items during Houston taxi and limousine inspection

Vehicle Overview	Vehicle Exterior	Wheelchair Accessible Vehicles
Horn*	Cleanliness	Operating condition
Windshield Wiper*	Body condition	Control pendant
Mirrors*	Bumper condition	Electrical wiring
Steering*	Trunk/luggage compartment	Vehicle interlock
Seat belts*	Weather stripping	Hand rails
Brakes*	Wheel and wheel covers	Lift mount and support points
Wheel Assembly*	Back up lights	Main lift pivot
Exhaust system*	Suspension	Platform and attachment points
Exhaust emission system*	Shock absorbers	Inner roll-stop
Headlight–Hi-beam indicator*	Engine	Platform roll-stop
Trail lamps*	Oil leak	Hydraulic system
Stop lamps*	Battery and battery system	All moving parts – lubricated
License plate lamp*	Electrical system	Test battery
Rear red reflectors*	Engine cooling system	Battery cables and connections
Turn signal lamps*	Belts	Manual backup system
Head lamps*	Fuel system	Test jump/transfer seat
Emergency flashers	Hood mechanisms	Wheelchair tie downs
Windshield	Transmission	
Frame	Differential	**Tires (tread depth and pressure)***
	Driveshaft drive axle shaft	
Vehicle Interior		
Climate control	**Additional Requirements**	
Air bags	State inspection– Current	
Instrumentation	State registration-Current	
Doors/Trim/Armrest/ Latch assemblies		
Foot pedal pads	**Taxicab Specific (if equipped)**	
Floor coverings	Communication equipment	
Headliner and Sun visor	Surveillance equipment	
Interior lighting		
Windshield windows mirror		
Seats		
Odors		

*Note: Items with * are also inspected under the Inspection Program.*

L.2. Analysis of Houston Taxi and Limousine Inspection Records

This section analyzes the inspection reports using Houston's inspection standard. A vehicle (taxi or limousine) fails the inspection if one or more defective items are identified during the inspection.

Of the 714 taxi and limousine vehicle inspection records processed, 590 (82.6%) failed the first inspection with one or more defective items. Only 124 (17.4%) vehicles passed the first inspection. Table L.2 summarizes the average vehicle age when the taxi was inspected and the average mileage information.

Table L.2. Average vehicle age and mileage for Houston taxis and limousines

	Number of Vehicles	Average Age	Average Mileage
All vehicles	714	5.9 years	257,640 miles
Vehicle failed first inspection	590 (82.6% first-time failure rate)	5.9 years	260,569 miles
Vehicle passed first inspection	124	5.7 years	243,727 miles

Note that the average age difference between vehicles that either failed or passed the first inspection is very small (0.2 years). In addition, all the vehicles have very high mileage—on average 257,640 miles, which is much higher than for a typical PV. The vehicles that failed the first inspection have a higher mileage (260,569 miles) than those that passed first inspection (243,727 miles). Figure L.2 shows the mileage distribution of all the 714 vehicles in database.

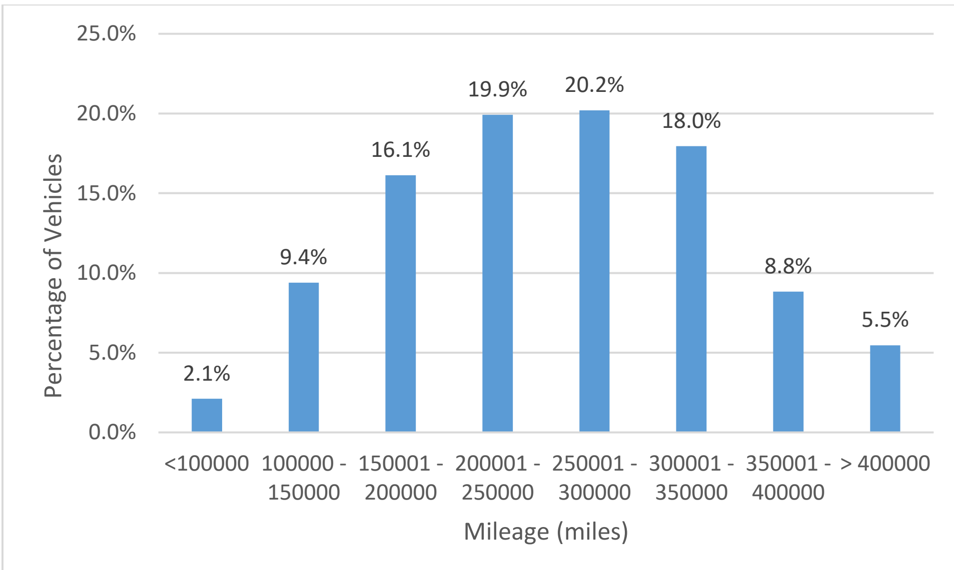


Figure L.2. Mileage distribution of Houston taxis and limousines

The study team found that high mileage is one shared characteristic of Houston taxis and limousines. As Figure L.2 illustrates, the mileage is “normally” distributed with most of the vehicles (74.2%) in the mileage range of 150,001 to 350,000.

It is noteworthy that 98.5% of the vehicles (581 out of 590) that failed the first inspection were re-inspected and passed the re-inspection. The inspection reports showed that HAF Inc. did not have re-inspection information on the other nine vehicles. For the 581 vehicles that were re-inspected, about 7 days on average passed before the vehicles were repaired and returned to pass the re-inspection. Figure L.3 presents the distribution of number of days between inspections.

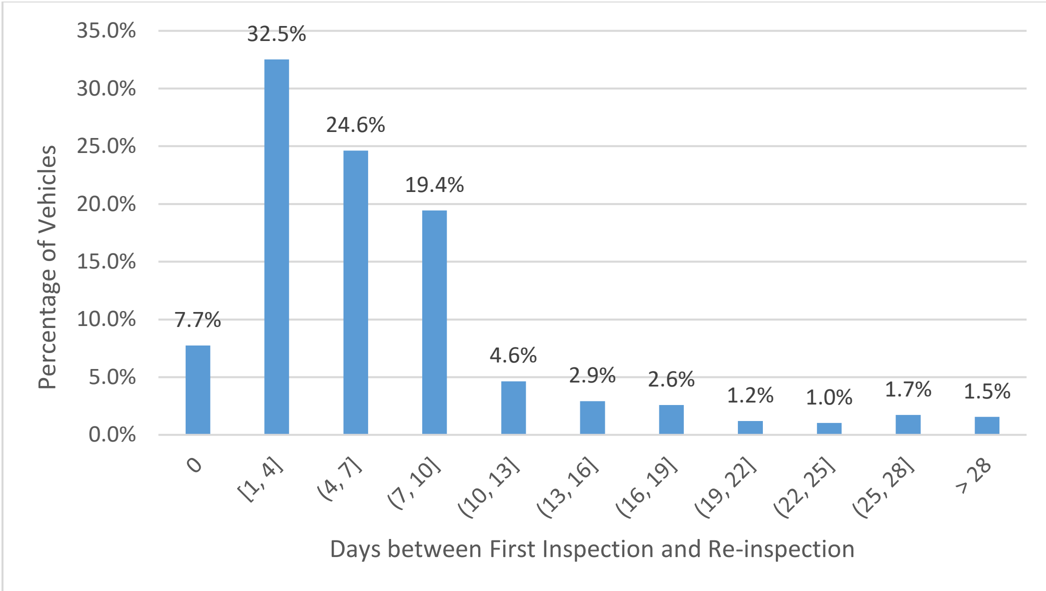


Figure L.3. Distribution of days between inspections for Houston taxis and limousines

Figure L.3 indicates that most of the vehicles (84.3%) completed the repair and passed the re-inspection within 10 days. Only 7.7% of the vehicles (45 out of 581) made the repair and passed the re-inspection on the same day, while 1.5% (9 out of 581) took more than 28 days. The longest duration in the database is one taxi that conducted re-inspection after 113 days.

The vehicle will fail an inspection if at least one or more defective items were identified during the inspection. Table L.3 lists the average number defective items for the vehicles.

Table L.3. Average failure reasons and defective items for Houston taxis and limousines

	Number of Vehicles	Average Defective Items
Vehicles failed first inspection	590 (82.6% first-time failure rate)	5
Vehicles passed first inspection	124	0
All vehicles	714	4

On average, each taxi or limousine inspected had about four defective items. The average number of defective items increases to five for those vehicles that failed the first inspection. Figure L.4 presents the distribution of number of defective items.

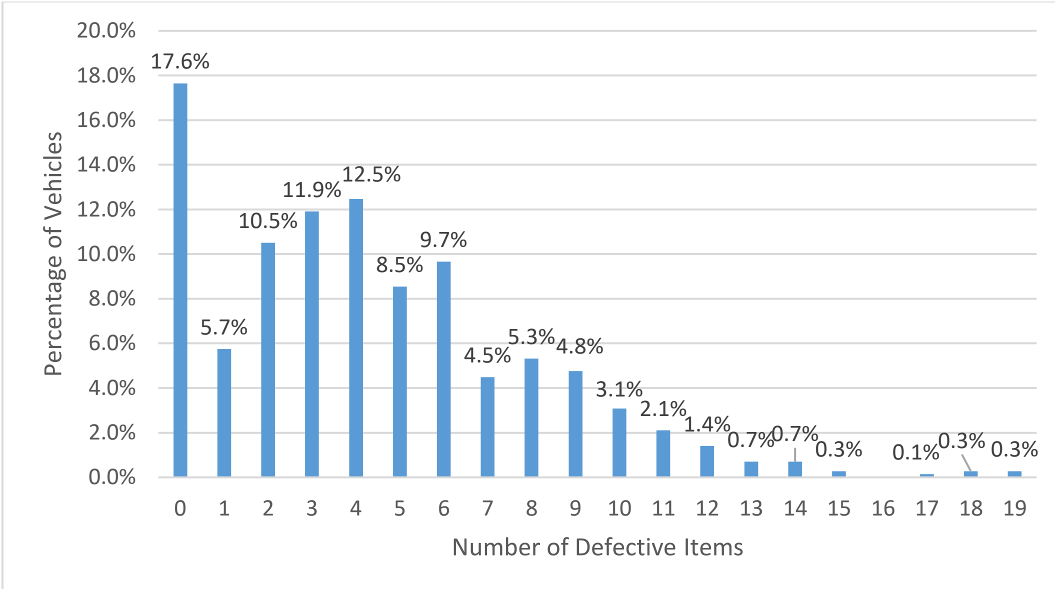


Figure L.4. Distribution of number of defective items for Houston taxis and limousines

Figure L.4 indicates that vehicles with no defective items (17.6%) are those that passed the first inspection. Of the 590 vehicles that failed first inspection, 420 (58.8%) have 6 or fewer defective items. There are 64 (9%) vehicles with 10 or more defective items. Two vehicles had 19 (the most) defective items.

Brakes represented the most common defect, found in 275 (38.5%) vehicles. The next most common defect was suspension (253 vehicles, 35.4%), then steering (181 vehicles, 25.4%), engine (166 vehicles, 23.2%), and head lamps (144 vehicles, 20.2%). This indicates that about 4 vehicles out of 10 would fail the inspection due to some defect associated with the brakes. Table L.4 summarizes all the defective items and the number of vehicles associated with them.

Table L.4. Summary of all defective items for Houston taxis and limousines

Defective Item	Number of Vehicles (percentage)	Defective Item	Number of Vehicles (percentage)
Brakes*	275 (38.5%)	Seat Belts*	22 (3.1%)
Suspension	253 (35.4%)	Exhaust System*	21 (2.9%)
Steering*	181 (25.4%)	Differential	19 (2.7%)
Engine	166 (23.2%)	Horn*	17 (2.4%)
Head lamps*	144 (20.2%)	Cleanliness	16 (2.2%)
Wheel and wheel covers	132 (18.5%)	Belts	13 (1.8%)
Doors/Trim/Armrest/Latch Assemblies	130 (18.2%)	State Inspection - current	12 (1.7%)
License plate lamp*	121 (16.9%)	Foot pedal pads	12 (1.7%)
Oil leaks	117 (16.4%)	Tail lamps*	9 (1.3%)
Battery and battery system	107 (15.0%)	Floor coverings	9 (1.3%)
Stop lamps*	100 (14.0%)	Headliner and sun visor	9 (1.3%)
Tires*	95 (13.3%)	Wheel Assembly*	8 (1.1%)
Instrumentation	76 (10.6%)	Seats	8 (1.1%)
Transmission	70 (9.8%)	Mirrors*	7 (1.0%)
Hood mechanisms	67 (9.4%)	Windshield	7 (1.0%)
Body condition	62 (8.7%)	Platform and attachment points	7 (1.0%)
Turn signal lights*	61 (8.5%)	State Registration - current	7 (1.0%)
Engine cooling system	59 (8.3%)	Headlight - Hi-beam indicator*	5 (0.7%)
Air bags	56 (7.8%)	Odors	4 (0.6%)
Climate Control (A/C and Heat)	55 (7.7%)	Electrical system	4 (0.6%)
Driveshaft/Drive axle shafts	52 (7.3%)	Weather stripping	4 (0.6%)
Windshield wipers*	50 (7.0%)	Frame	3 (0.4%)
Bumper condition	39 (5.5%)	Communication equipment	3 (0.4%)
Trunk/luggage compartment	38 (5.3%)	Fuel system	2 (0.3%)
Back up lights	37 (5.2%)	Emergency flashers	2 (0.3%)
Exhaust emission system*	35 (4.9%)	Interior lighting	1 (0.1%)
Shock absorbers	35 (4.9%)	Wheelchair tie downs	1 (0.1%)
Windshield/windows/mirrors (interior)	27 (3.8%)		

*Note: Items with * are also included in Inspection Program.*

Figure L.5 presents the top 15 defective items that failed an inspection under Houston inspection standard.

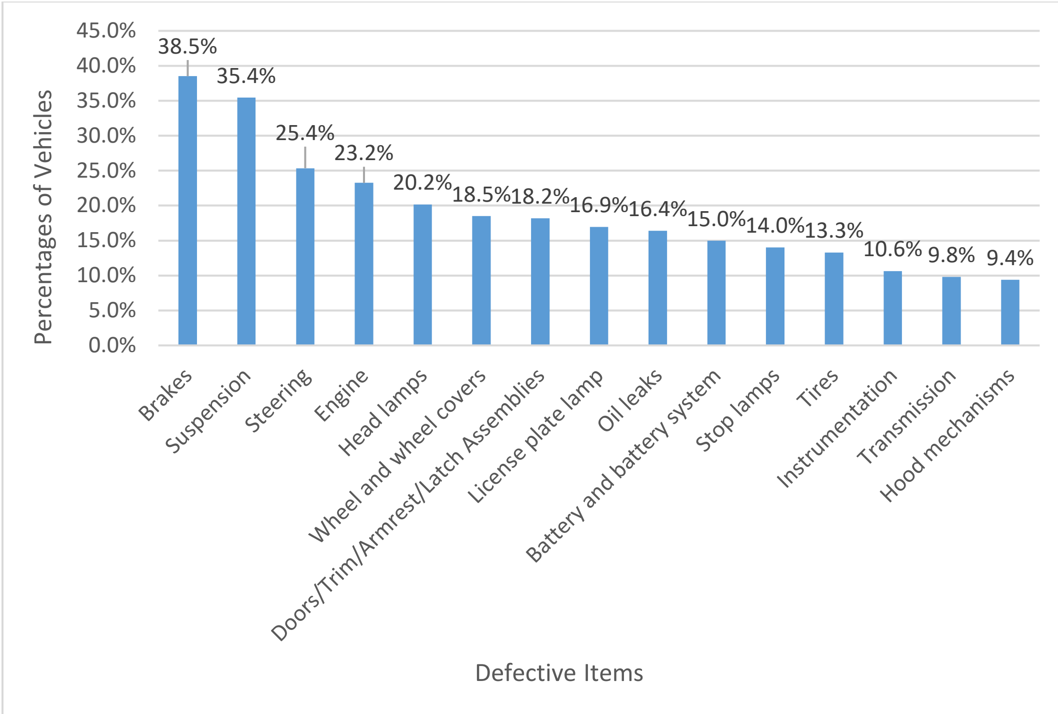


Figure L.5. Top 15 defective items for Houston taxis and limousines

L.3. Analysis of Houston Taxi and Limousines Inspection Records Using Inspection Program Standards

The high rate of first-time failure for these high-mileage vehicles signifies the importance of ensuring that PVs for used for commercial purposes (including PVs used by the increasingly prevalent transportation network companies such as Uber and Lyft) be subject to inspection. Given that the Houston program had more stringent standards, the study team was interested in determining how these same vehicles would fare under the Inspection Program standards.

Houston's inspection program examined about 77 items, most of which are not required by the Inspection Program (items without an asterisk in Table L.4). In other words, some vehicles failed that the Houston inspection might pass the mandatory state inspection. This section analyzes the inspection records through the lens of the Inspection Program standards. The items considered in this section are the ones marked with asterisks in Table L.4.

Of the 714 vehicle records the study team examined, 71.6 % (511 vehicles) would have failed the first inspection with one or more defective items under the Inspection Program standard, which is an 11% decrease compared with the Houston Standard because fewer items were inspected. This means 203 (28.4%) vehicles would have passed the first inspection under Inspection Program standard. Table L.5 summarizes Inspection Program evaluation, the average vehicle age when the taxi was inspected, and the average mileage information.

Table L.5. Inspection Program evaluation results under Inspection Program standards, with average vehicle age and mileage for Houston taxis and limousines

	Number of Vehicles	Average Age	Average Mileage
All vehicles	714	5.9 years	257,640 miles
Vehicle would fail first inspection	511 (71.6% first-time failure rate)	5.9 years	261,024 miles
Vehicle would pass first inspection	203	5.8 years	249,136miles

The average mileage of vehicles that would have failed the first inspection (261,024 miles) is higher than that of the vehicles that would have passed the inspection (249,136 miles).

On average, there are about 2 defective items with each taxi or limousine under the Inspection Program standard. Figure L.6 presents the distribution of number of defective items under Inspection Program standard.

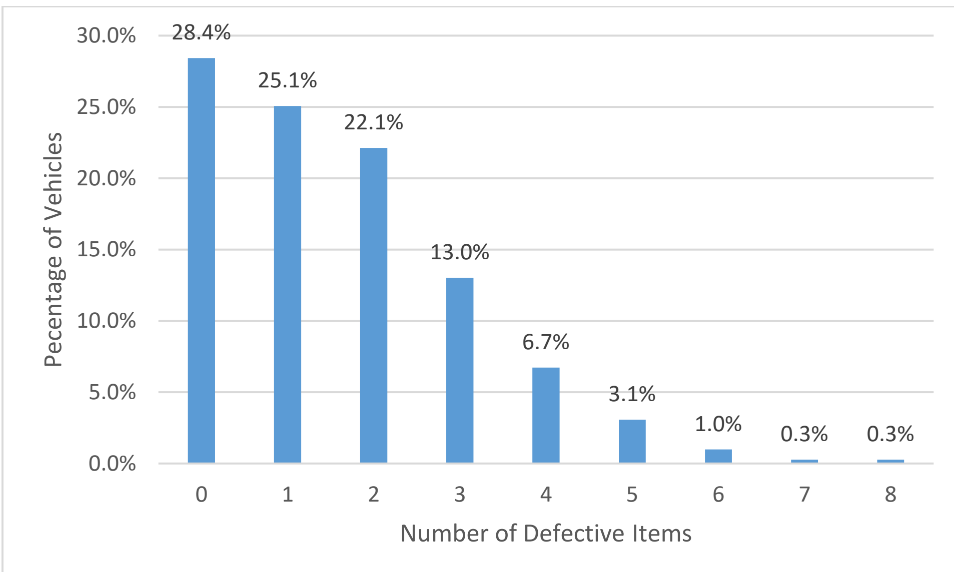


Figure L.6. Distribution of number of defective items for Houston taxis and limousines under Inspection Program standards

Figure L.6 indicates that 28.4% of the vehicles would pass the inspection under the TxDPS Inspection Program standard. Of the 511 vehicles that would fail the first inspection, 430 (60.2%) have three or fewer defective items. The remaining 81 (11.3%) vehicles with 4 or more defective items. Two vehicles had eight (the most) defective items.

In terms of defective items, brakes are still the most common at 275 (38.5%) vehicles, followed by steering (181 vehicles, 25.4%), head lamps (144 vehicles, 20.2%), license plate lamps (121 vehicles, 16.9%), stop lamps (100 vehicles, 14.0%), and tires (95 vehicles, 13.3%). Table L.6 summarizes all the defective items and the number of vehicles associated with them under the Inspection Program standards.

Table L.6. Summary of all defective items for Houston taxis and limousines under Inspection Program standards

Defective Item	Number of Vehicle (percentage)	Defective Item	Number of Vehicle (percentage)
Brakes	275 (38.5%)	Exhaust emission system	35 (4.9%)
Steering	181 (25.4%)	Seat Belts	22 (3.1%)
Head lamps	144 (20.2%)	Exhaust System	21 (2.9%)
License plate lamp	121 (16.9%)	Horn	17 (2.4%)
Stop lamps	100 (14.0%)	Tail lamps	9 (1.3%)
Tires	95 (13.3%)	Wheel Assembly	8 (1.1%)
Turn signal lights	61 (8.5%)	Mirrors	7 (1.0%)
Windshield wipers	50 (7.0%)	Headlight - Hi-beam indicator	5 (0.7%)

Note: All items in the table are included in Inspection Program.

Figure L.7 presents the top 15 defective items that fail an inspection under Inspection Program standard.

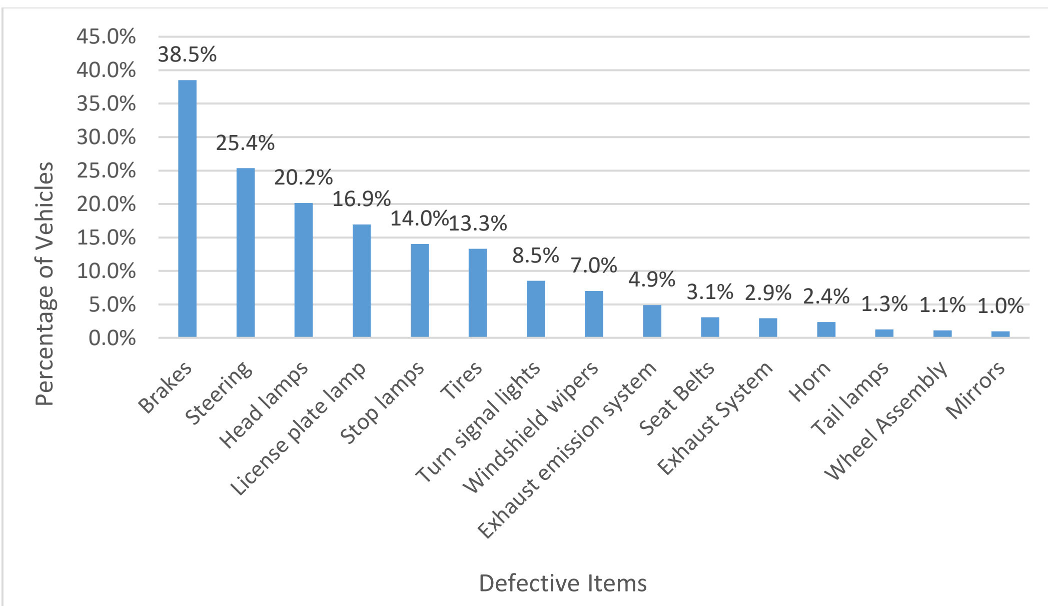


Figure L.7. Top 15 defective items for Houston taxis and limousines under Inspection Program standards

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