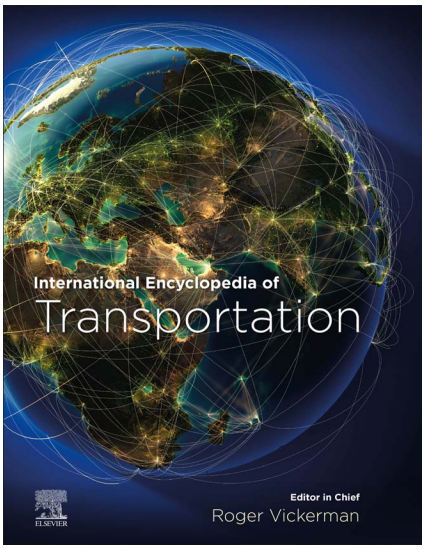

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Automobile Safety Inspection

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Introduction

According to 2011–16 Fatality Analysis Reporting System (FARS), approximately 2.6% of fatal crashes in the United States involved vehicle-related faults as a primary contributing factor. Previous studies indicate that a majority of technological defects are identified during inspection of wearable parts such as lights, tires, and brakes. However, the proportion of vehicle failures that can be contributed to crash occurrences was revealed to not have changed fundamentally since the 1970s. In the United States, the National Highway Traffic Safety Administration (NHTSA) suggests that each state implement a program to inspect all registered vehicles (annually or biennially) to guarantee that unsafe vehicles are taken off the roads. Nonetheless, it is critical to acknowledge that studies lack any correlation between crash rates and inspection programs related to vehicle component failure. When legislation restricted the NHTSA's authority to reserve highway funding in 1976, the number of states with vehicle inspection programs has decreased. As of July 2015, only 16 states continue to implement the recommended regular safety inspection program.

Safety inspection regulations in Canada vary from province to province. The Ministry of Justice in Canada provides a detailed regulation in the document "Motor Vehicle Safety Act" (The Ministry of Justice, Canada, 2019). According to the directive 2014/45/EU of the European Parliament and of the Council on "periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC" (issued on April 3, 2014), "all member states need to carry out periodic safety inspections for most types of motor vehicles with designed speed exceeding 40 kmph/25 mph" (Official Journal of the European Union, 2014). In Australia, each state or territory preserves the authority to set its own safety inspection regulations. Poorly designed and old vehicles contribute significantly to traffic deaths in the Asian countries. Automobile safety inspection programs are not effectively regulated through design standards or maintained through mandatory vehicle inspection schemes (World Resources Institute, 2018).

While vehicle safety inspections could likely decrease the possibility of crashes, the degree of the reduction is difficult to quantify. Earlier studies do not implicate that safety inspection programs have zero effect on the reduction of crashes; however, the results are inconclusive. Additionally, international studies were unable to determine a relation between inspection programs and crash rates. Conclusively, there is an absence of research on the effectiveness of vehicle safety inspections on crash reduction. This study provides a short overview on this topic with inclusion of research directions and future scopes.

Literature Review

Limited research has been conducted on the effects of automobile safety inspection programs. One earlier study (conducted in 1999) recorded the results of several earlier studies. Using various sources, the previous studies (conducted before 1995) displayed contradictory findings about the significance of automobile safety inspections. Using panel data from all US states during the years of 1981–93, this study found no evidence that inspections considerably decreased injury or fatality rates. The Federal Motor Carrier Safety Administration has revoked an arrangement for commercial drivers to lodge inspection reports if vehicle deficiencies or flaws are not obvious. Regardless, the regulation does not affect the responsibility of drivers to report any deficiencies or faults to the motor carrier on the condition of a vehicle.

The United States Government Accountability Office (GAO) analyzed the costs and safety benefits of operating state vehicle safety inspection schemes, obstacles faced by states in administering these schemes, and tasks that could be taken by NHTSA to assist states with these initiatives (US GAO, 2015). The study evaluated state data and data from NHTSA (2009–13) for crash trends

attributable to the failure of vehicle components; analyzed studies that reviewed relations between safety examinations and outcomes; and interviewed inspection representatives from 15 states. The GAO also interviewed representatives from five states that discontinued their safety inspection programs since 1990. The officials representing the five states and the District of Columbia cited the lack of concrete evidence to rationalize the efficiency of the system to conserve financial resources as one of the major reasons for eliminating the program. The study concluded that state officials adopted different criteria and chose not to include technological advances in their inspection systems, likely decreasing their inspection program's safety benefits. However, the study found that the states support using LED brake lights to enhance safety versus the conventional one. Similarly, the states have established more rigid system guidelines for inspection stations to be implemented to diminish fraudulent behavior such as fingerprint scanners for proper identification until inspections are carried out. The states have also begun to plan workforce reports, introduce more rigorous program guidelines, and develop digital information systems while addressing the challenges. The study suggested that to improve aid to states concerning the periodic motor vehicle inspection policy, there is a strong need to direct the NHTSA Administrator to develop and manage a communication and management framework with states to respond to questions from officials of the State Security Inspection Program and relay appropriate vehicle inspection data.

Vlahos et al. (2009) used Pennsylvania vehicle registration data. The researchers found that the failure rate of safety inspection for light-duty vehicles is between 12% and 18% (well above the often-cited rate of 2%). Older vehicles (more than 3 years old or having mileage greater than 30,000 miles) usually show higher rates. The evaluation of the new vehicles (less than or equal to one year old) shows that the failure rates of these vehicles are over zero. It is important to note the newer technologies, safer systems, and driver assistance make the vehicle fleets safer over the past few years. The current trend shows that inspection failure rate does not appear to be declining soon. This study also displayed that correct inspection data are limited, and vehicles are frequently inspected inaccurately. A similar analysis was conducted in North Carolina (North Carolina General Assembly Program Evaluation Division, 2008).

Das et al. (2018) explored 67,201 crash-related vehicle complaint reports from NHTSA database. This study found that major vehicular defects are associated with air bags, brake systems, seat belts, and speed controls. In a follow-up study, Das et al. (2019) conducted a statistical significance test to establish the efficacy of vehicle safety systems dependent on the existing states with and without safety inspection. The study used NHTSA automobile complaint data and FARS databases to evaluate the efficacy of regulatory vehicle safety components in different US states.

It is challenging to examine the advantages and disadvantages of state inspection programs, and state program officials often face challenges in program operations. However, these programs do ultimately enhance vehicle safety. It is obligatory of the administrator of NHTSA to establish and manage open communication with these state programs to relay important information and assist the states regarding the motor vehicle inspection guideline. With these enhancements, these programs could have more of an impact on improving vehicle safety in their respective states.

State Laws and Effectiveness Measure

Vehicle Inspection Program

In the United States, researchers are limited in determining the association between crash occurrences and vehicle-related failures by the lack of data. FARS data only provide fatality-related crash data at a national level. Due to the absence of national crash data with other severity levels, the crash rate comparison for inspection programs is hard to attain. Some states attribute the elimination of these programs. However, states generally do not accurately consider the costs of overseeing and managing these programs. The operating costs of inspection programs are entangled with additional programs, so determining the expense of vehicle inspection operation is not entirely possible. Also, there is typically a fee associated with safety inspections, which returns money to the state, but the amount varies between states. These funds are allocated to where each state deems fit before they are given to the inspection program. Currently, there are no states that have federally funded inspection programs (US GAO, 2015). Without properly identifying the operational costs of vehicle inspection programs, states cannot determine whether the costs of these programs outweigh the effects on crash rates. Because of the lack of evidence proving the effectiveness of the program or saving financial resources, some states have eliminated their programs.

States with inspection programs require information and guidance from the NHSTA to improve their program operations. As innovative vehicle technologies emerge, states need guidance in integrating these technologies as well as adding new requirements to their inspection programs. However, the NHTSA does not have a definite answer regarding the effectiveness of automobile inspection programs.

Table 1 displays which states have different types of automobile safety inspection regulations (i.e., annual, biennial, and random). As shown in **Table 1**, the following states have some sort of automobile safety inspection regulations: Delaware,

Table 1 Automobile inspection programs by state

Duration	*States*	*Description*
Annual	HI, LA, ME, MA, NH, NY, NC, PA, TX, VT, VA, WV	Require an annual vehicle safety inspection (LA: in areas where emissions inspections are needed)
Biennial	DE, LA, MO, RI	Require a biennial inspection (LA: in areas where emissions inspections are not needed)
Random	UT	Random roadside inspections

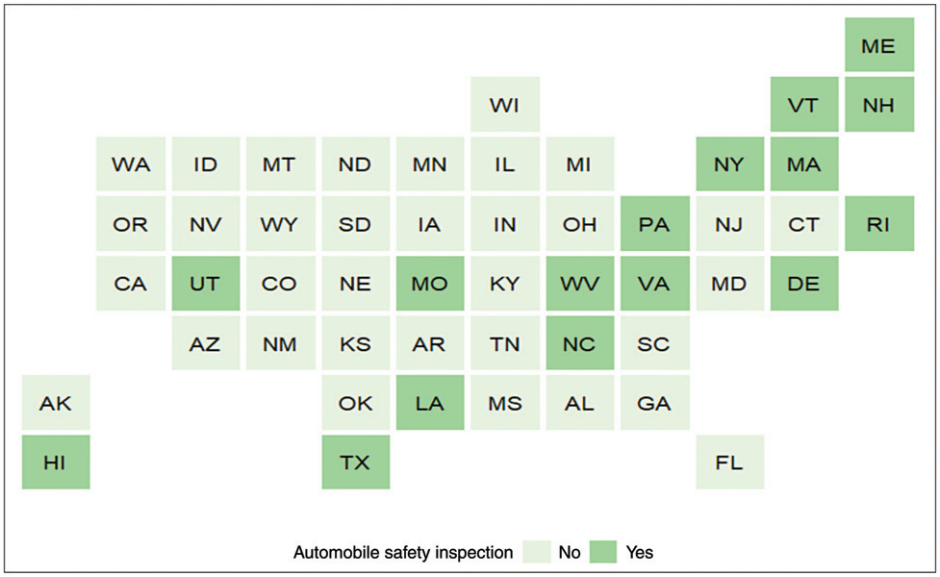

Figure 1 Vehicle inspection requirement by state.

Hawaii, Louisiana, Maine, Massachusetts, Missouri, New Hampshire, New York, North Carolina, Pennsylvania, Rhode Island, Texas, Utah, Vermont, Virginia, and West Virginia. A majority of the states have annual inspection programs and three states (Delaware, Missouri, and Rhode Island) require biennial inspections. Louisiana has both annual and biennial inspections based on the areas with emissions inspection requirement. According to the GAO report, Utah has random roadside automobile inspection programs. The NHTSA specified protocol outlines the minimum requirement for several important vehicles components such as tires, brakes, steering wheel, suspension system and wheel rotation or assemblies for safety inspections. This standard is applicable to all states with automobile inspection regulations (i.e., the states listed in **Table 1**). However, additional inspection requirements such as headlights, safety straps, horns, wiper blades vary based on the policies and regulations in each state (US GAO, 2015).

Fig. 1 shows the map of the United States with dark green squares indicating states that have some sort of inspection program. The light green squares indicate states with no automobile inspection program. As shown in **Fig. 1**, only 36% of the states has some sort of inspection programs.

Data Sources

FARS Data

The NHTSA has maintained the FARS database since 1975. During 1975–2017, there were 1,615,539 fatal crashes in the United States. The FARS database contains data from all 50 states, the District of Columbia, and Puerto Rico; it has information for 1.6 million fatal crashes in the United States. The major sources of this comprehensive database include police recorded crash reports, hospital entries and medical reports, emergency services, registration files, and state department of transportation records. The FARS database contains a comprehensive list of data elements in each fatal crash by characterizing crash event, involved vehicles and peoples, and event hierarchy. FARS data are a vital source for many researchers to understand the key contributing factors that lead to a fatal crash occurrence, such as roadway geometry, driver and vehicles, and ultimately working toward crash prevention.

NHTSA Vehicle Complaint Data

As an additional road safety improvement effort, the NHTSA maintains records of public provided complaints about vehicles, vehicle components, and transportation-related equipment. The database also contains vehicle and crash information to some extent. The data have been developed based on the complaints of vehicle owners or attorneys by several communication systems such as phone, fax, mail, or online submission. In these reports, the participants provide vehicle component failure information and describe the associated consequences for the failure. After receiving reports, Office of Defects Investigation analysts identify the failed component and complete the "specific component's description" field. It is important to note that several records may exist for a single event or crash because there is a possibility of multiple failures in one event or crash (Das et al., 2019). Additionally, this database can provide insights on safety issues associated with vehicle models or components, identify safety trends for proper impact, track ongoing recalls, and order investigations for defects that may result in safety failure. The database developed till 2018 incorporates one and half million vehicle or vehicle component complaint reports in structured form with a wide list of variables. Around 8% of these reports involve fatalities or some level of injury. The complaints file contains all safety-related defect complaints received by NHTSA since January 1, 1995, as well as some incomplete rerecords for earlier years.

Das et al. (2019) applied a statistical significance test to this data to investigate the safety effectiveness of state-maintained vehicle inspections. The analysis used the "Cohen's d" statistic to evaluate the differences in mean measures (complaints, complaint involved crashes, and fatal crashes from FARS) between the states with and without automobile inspection programs during the two time periods. This study conducted statistical significance test (using Cohen's d measure) to determine the effectiveness of the vehicle safety inspection programs based on the states with and without automobile inspection program in place. The results from the vehicle complaint data showed that states with inspection programs expect a smaller number of monthly vehicle complaints and vehicle failure-related crashes than the states without safety inspection programs. This supports the claim that the mandatory vehicle inspection programs have a positive effect on safety. In contrary, the analysis of the FARS data showed no evidence on the positive effectiveness of safety inspection programs.

Future Scope and Research Direction

Further research concerning traditional methods such as regression modeling is required to examine the effectiveness of automobile safety inspection programs. Additionally, more advanced methods such as machine learning and deep learning can be applied to mitigate the research gap. Using innovative data source such as NHTSA vehicle complaint data is noteworthy. However, it is important to note that NHTSA may not receive all the vehicle complaints and so the results presented the recent study may not be comprehensive. There is a need for advanced analysis in reducing bias associated with the underreporting of these complaints. Furthermore, since the analysis using FARS data did not show any evidence of effectiveness of these programs, advanced tools such as machine learning models can be applied to reexamine the hypothesis of the effectiveness of the safety inspection programs using FARS data. Alternative data source such as General Estimates Systems (GES) can be used; however, precautions should be taken as the GES estimated values are not the actual counts like the FARS database. Additionally, severity specific analysis can be conducted. Moreover, several new data sources should be compiled to perform a comprehensive analysis on the effectiveness of automobile safety inspection laws. Future studies can explore the following datasets:

- **Exposure Data:** Vehicle miles traveled is the most commonly used exposure measure because it most directly captures exposure to crash occurrences. The Federal Highway Administration Highway Statistics publication provides annual estimates by roadway function class and vehicle type. The Bureau of Labor Statistics is a good source of employment-related data. The US Department of Commerce is a reliable source for gross domestic product estimates by state and year.
- **Department of Public Safety (DPS) Inspection and Citation Data:** State DPS authorities maintain roadside stop and citation data and as well the data related to the vehicle safety inspection. Inspection data are available by type of inspection certificate issued.
- **Crash Data:** State specific crash data can be beneficial in exploring the effectiveness of the automobile inspection programs. An alternative data source is GES.
- **Revenue Data:** Revenue data for the states can be collected from the state's department of transportation and/or the comptroller of public accounts.

The evaluation of the safety inspection programs on fatal crashes is challenging because crash fatalities are relatively rare events in the context of the overall amount of travel; also, relatively few police reports attribute the cause of fatal crashes to vehicle component failure. Additionally, GES or state specific crash data can provide additional insight into the effect of inspection programs. Future studies can examine the disposition of the associated fees and the intended use of the funds for the states with automobile inspection programs. Research can also explore how similar services are funded in the other 34 states as well. Researchers can estimate revenue impacts by examining the reported proceeds in each of the identified funds, both in the aggregate and on a per capita basis.

Conclusion

Despite the belief that periodic inspection of registered vehicles can improve safety, the number of states mandating safety inspections dropped from a high of 31 in 1975 to 16 in 2015. It is widely believed that safety inspections can reduce vehicles with issues that may contribute to the improvement of roadway safety. However, research about the effects of these programs is inconclusive due to limitation of comprehensive databases. It is important to note that forms of automobile inspection such as annual and biennial only safeguard some key components of the automobiles. In many cases, these inspections are only able to identify a portion of potential automobile defects. Furthermore, the failure of inspectors to take a proper amount of care can result in ineffective safety inspection programs, which can create societal and economic loss. The costs of ineffective programs include costs related to inspection site visits, drivers' time, inspection-related resources, and nonmandatory repairs that required for privately owned cars to pass the inspection. These costs vary based on each state's supporting resources and density of inspection booths.

Safety inspection regulations in the countries outside of the United States widely vary. In Canada, the regulations vary from province to province. The European countries maintain safety regulation programs; however, the regulations differ in different countries. Each state or territory of Australia maintains its own safety inspection regulations. In Asia, automobile safety inspection programs are not effectively regulated through mandatory inspection programs.

Many state policymakers have questioned the effectiveness of automobile safety inspection programs. This uncertainty required a more robust scrutiny of the effectiveness of current inspection programs that will consider the inspection process by analyzing the

state of vehicles before they undergo the inspection rather than after it is conducted. The compelling findings of one of the recent studies demonstrated that safety inspection failure rates remain high, which calls into question why vehicle inspection regulations are not federally mandated like emission inspections.

The framework development and implementation of more robust data collection systems is the key to improve program efficiency by allowing for stronger oversight and improved management. The paper-based data system for inspection programs requires significant program oversight and enhancement. The system could be more efficient if it contained the functionality of electronic data collection and error checking. The fact of the matter is that few states have vehicle safety inspection programs at present, and even fewer states maintain electronic safety inspection records. Because of this, the insights on these programs are limited. More advanced data sources and analytical methods are necessary to mitigate this crucial research gap.

Biography

Dr Subasish Das is an Associate Transportation Researcher at the Texas A&M Transportation Institute (TTI). He received his Master of Science in Civil Engineering in 2012 and his PhD in Civil Engineering in 2015 both from the University of Louisiana at Lafayette. He has more than 10 years of national and international experience associated with transportation safety engineering research projects. His primary fields of research interest are roadway safety, roadway design and operation, mobility, machine learning, deep learning, and natural language processing. Dr Das is the author or coauthor of over 80 peer reviewed journal articles and research reports. He is also the author of the CRC Press book, "*Artificial Intelligence in Transportation Safety*," which will be published in 2020.

Relevant Websites

Fatality Analysis Reporting System (FARS). https://www-fars.nhtsa.dot.gov/Main/index.aspx
National Highway Traffic Safety Administration (NHTSA). Flat files of Office of Defects Investigation (ODI). https://www-odi.nhtsa.dot.gov/downloads/

References

Das, S., Mudgal, A., Dutta, A., Geedipally, S., 2018. Vehicle consumer complaint reports involving severe incidents: mining large contingency tables. Trans. Res. Rec. J. Transp. Res. Board 2672 (32), 72–82.
Das, S., Geedipally, S.R., Dixon, K., Sun, X., Ma, C., 2019. Measuring the effectiveness of vehicle inspection regulations in different states of the U.S. Transp. Res. Rec. J. Trans. Res. Board 2673, 208–219.
Official Journal of the European Union, 2014. Directive 2014/45/EU of the European Parliament and of the Council on 'periodic roadworthiness tests for motor vehicles and their trailers and repealing Directive 2009/40/EC'. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014L0045&rid=5.
North Carolina General Assembly Program Evaluation Division, 2008. Doubtful return on the public's $141 million investment in poorly managed vehicle inspection programs – Final Report to the Joint Legislative Program Evaluation Oversight Committee, Report No. 2008-12-06.
The Ministry of Justice, Canada, 2019. Motor vehicle safety act. https://laws-lois.justice.gc.ca/PDF/M-10.01.pdf.
US Government Accountability Office (GAO), 2015. Vehicle safety inspections: improved DOT communication could better inform state programs, Report No. GAO-15-705, Washington, DC.
Vlahos, N., Lawton, S., Komanduri, A., Popuri, Y., Gaines, D., 2019. Pennsylvania's vehicle safety inspection program effectiveness study. The Pennsylvania Department of Transportation. Report No.: PA-2009-004-070609.
World Resources Institute, 2018. Sustainable & safe: a vision and guidance for zero road deaths. http://pubdocs.worldbank.org/en/912871516999678053/Report-Safe-Systems-final.pdf.

Further Reading

Christensen, P., Elvik, R., 2006. Effects on accidents of periodic motor vehicle inspection in Norway. Accid. Anal. Prev. 39, 47–52.
Institute for Road Safety Research, 2012. Periodic vehicle inspection (MOT), SWOV, Leidschendam, The Netherlands. https://www.swov.nl/file/13376/download?token=ondCjOiL.
Keall, M.D., Newstead, S., 2013. An evaluation of costs and benefits of a vehicle periodic inspection scheme with six-monthly inspections compared to annual inspections. Accid. Anal. Prev. 58, 81–87.
Merrell, D., Poitras, M., Sutter, D., 1999. The effectiveness of vehicle safety inspections: an analysis using panel data. South. Econ. J. 65 (3), 571–583.
Miller, R.E., 2014. FMCSA ends inspection reporting unless drivers find vehicle defects. Trans. Top. 26, 5.
Peck, D., Matthews, H.S., Fischbeck, P., Hendrickson, C.T., 2015. Failure rates and data driven policies for vehicle safety inspections in Pennsylvania. Trans. Res. A Policy Prac. 78, 252–265.