TECHNICAL REPORT STANDARD PAGE

1. Title and Subtitle
The Impact of the Louisiana Grade Crossings: A Synthesis and System Analysis

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5. Report No.
FHWA/LA.21/661

6. Report Date
February 2022

7. Performing Organization Code
LTRC Project Number: 21-1SS
SIO Number: DOTLT1000372

8. Type of Report and Period Covered
Final Report
05/2020-11/2021

9. No. of Pages
60

10. Supplementary Notes
Conducted in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

11. Distribution Statement
Unrestricted. This document is available through the National Technical Information Service, Springfield, VA 21161.

12. Key Words
Grade crossing; safety; closure; incentive program; multimodal transportation

13. Abstract
Louisiana has over 3000 at-grade crossings of public roads with railroads. The number of private road/driveway crossings is unknown but likely exceeds the number of public crossings. In 2018, 91 grade crossing collisions were recorded, including six fatalities, in Louisiana. Although Louisiana has witnessed a decline in highway-rail crossing accidents in recent years, which mirrors national trends, it is still one of the 10 states that has the highest number of grade crossing collisions on average. At-grade crossings of public and private roads with railroads create unique intersections where trains and vehicles and other users meet. These are different modes of transportation with distinct physical and operational characteristics. In addition to present safety concerns, at-grade crossings also hamper railroad operations and efficiency. The primary goal of this study was to investigate incentive programs and their effectiveness for reducing the number of crossings through a comprehensive

literature review and surveying and interviewing professionals in Louisiana. This study also looked for funding sources, concerns, and factors and selection process of crossing closure. The results show that the vast majority of agencies in Louisiana are concerned by the safety at railroad grade crossings with one third of them who would support closing crossings to reduce their concerns. Besides safety, three other primary concerns were identified: the condition and maintenance of crossing related facilities, traffic management, and access for active transportation (pedestrians and bicycles). There is no incentive programs for at-grade crossing closure offered by DOTD or other local agencies in Louisiana currently, except New Orleans Public Belt Railroad Commission. The professionals ranked the effectiveness of provided incentive programs by road improvement as the most effective, followed by nearby crossing grade separation, nearby crossing improvement, cash incentives, and track relocation. Based on the literature and survey results, this study recommends that any type of incentive program would work better than no incentive program. In fact, the combination of multiple incentive programs may be more effective than any individual program, and the state may utilize federal funding opportunities. For implementation, context-sensitive, accessible, and transparent policies, public education, and stakeholder engagement may help to improve the overall transportation safety and efficiency at railroad grade crossings.

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LTRC Project No. 21-1SS
SIO No. DOTLT1000372

conducted for
Louisiana Department of Transportation and Development
Louisiana Transportation Research Center

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February 2022

Abstract

Louisiana has over 3000 at-grade crossings of public roads with railroads. The number of private road/driveway crossings is unknown but likely exceeds the number of public crossings. In 2018, 91 grade crossing collisions were recorded, including six fatalities, in Louisiana. Although Louisiana has witnessed a decline in highway-rail crossing accidents in recent years, which mirrors national trends, it is still one of the 10 states that has the highest number of grade crossing collisions on average. At-grade crossings of public and private roads with railroads create unique intersections where trains and vehicles and other users meet. These are different modes of transportation with distinct physical and operational characteristics. In addition to present safety concerns, at-grade crossings also hamper railroad operations and efficiency.

The primary goal of this study was to investigate incentive programs and their effectiveness for reducing the number of crossings through a comprehensive literature review and surveying and interviewing professionals in Louisiana. This study also looked for funding sources, concerns, and factors and selection process of crossing closure.

The results show that the vast majority of agencies in Louisiana are concerned by the safety at railroad grade crossings with one third of them who would support closing crossings to reduce their concerns. Besides safety, three other primary concerns are identified: the condition and maintenance of crossing related facilities, traffic management, and access for active transportation (pedestrians and bicycles). There is no incentive program for at-grade crossing closure offered by DOTD or other local agencies in Louisiana currently, except New Orleans Public Belt Railroad Commission. The professionals ranked the effectiveness of provided incentive programs by road improvement as the most effective, followed by nearby crossing grade separation, nearby crossing improvement, cash incentives, and track relocation.

Based on the literature and survey results, this study recommends that any type of incentive program would work better than no incentive program. In fact, the combination of multiple incentive programs may be more effective than any individual program, and the state may utilize federal funding programs and opportunities. For implementation, context-sensitive, accessible, and transparent policies, public education, and stakeholder engagement may help to improve the overall transportation safety and efficiency at road-railroad at-grade crossings.

Acknowledgments

The completion of this synthesis and system analysis of grade crossings in Louisiana would not have been possible without the participation of many transportation professionals and others, and the University of New Orleans and the Louisiana Department of Transportation and Development express its appreciation to those individuals and parties who participated as stakeholders in this effort.

The authors wish to thank the University of New Orleans Transportation Institute staff and students who assisted with this work, including Carol Short and Delinda Swanson.

Implementation Statement

This project provides incentive programs for the closure of at-grade railroad crossings that can be employed directly by DOTD, local governments, railroads companies, and industries that rely on rail service. It helps to encourage different public and private sectors and local communities to be more engaged in the grade crossings related issues. Ultimately, it helps to enhance the safety of all transportation users, improve the efficiency of Louisiana's multimodal transportation system, and make it better to serve the needs of the economy, reduce the environmental impacts, and improve the public health in general.

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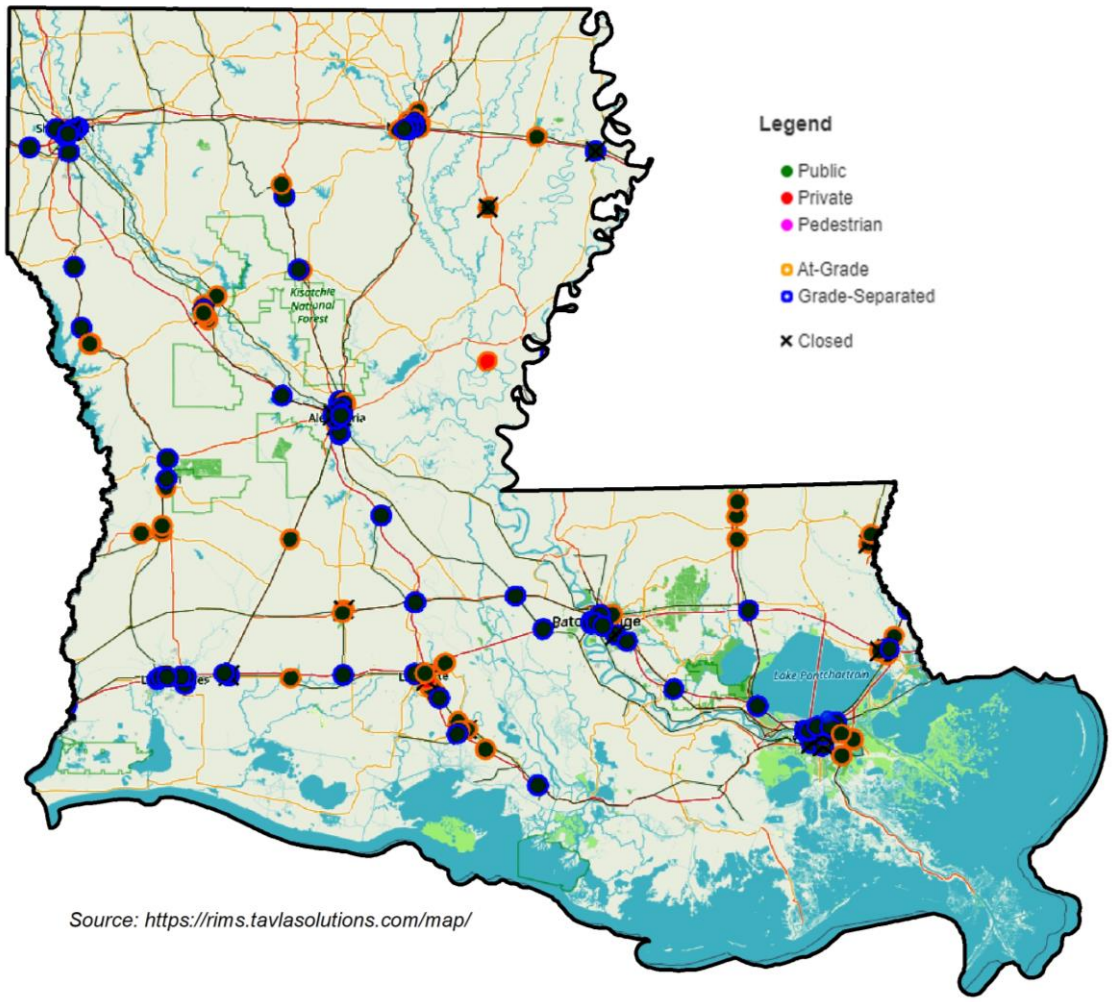
Introduction

Louisiana has over 3,000 at-grade crossings of public roads with railroads. The number of private road/driveway crossings is unknown but likely exceeds the number of public crossings. In 2018, the overall number of collisions and the number of grade crossing fatalities across the nation were 2,220 and 273, respectively (Bureau of Transportation Statistics). Simultaneously in Louisiana, 91 grade crossing collisions were recorded, including six fatalities. Although Louisiana has witnessed a decline in highway-rail crossing accidents in recent years, which mirrors national trends, Louisiana is one of the 10 states that has the highest number of grade crossing collisions on average.

At-grade crossings of public and private roads with railroads create unique intersections where trains and vehicles and other users meet. These are different modes of transportation with distinct physical and operational characteristics. In addition to present safety concerns, at-grade crossings also hamper railroad operations and efficiency. The 2015 Louisiana Statewide Transportation Plan includes an element that calls for research into incentive programs that can be used to entice voluntary closure of public and/or private crossings. This project responded that call through a thorough literature review, survey, and interviews.

Figure 1. An overview of crossings in Louisiana



Literature Review

Many railroads were initially allowed to build at-grade level crossings across the roads to avoid additional capital costs of grade separation. At-grade crossings of public roads with railroads create unique intersections because trains and vehicles are two different modes of transportation with distinct physical and operational characteristics [1]. That makes railroad-public road grade crossings responsible for numerous collisions between trains and vehicles annually [2]. In the past, safety in such intersections was not a major issue due to the limited numbers of trains and their slow paces. However, with the increase of road and railroad traffic, both the frequency and severity of incidents at crossings have been increased. In the past few decades, although the number of fatalities has significantly dropped by eliminating some crossings and providing safety improvements, there is still demand for preventing incidents and keeping people safer around railroad crossings [1] [3].

In 2018, the overall number of collisions and number of grade crossing fatalities across the nation were 2,220 and 273, respectively [4]. At the same time in Louisiana, 91 grade crossing collisions were recorded, including 6 fatalities [5]. Such severe crashes impose economic and social burdens on communities within the vicinity of these crossings [6]. According to the Federal Railroad Administration (FRA), closure of crossing is the safest and strongest alternative for unneeded highway-railroad crossings. Therefore, at-grade crossing closure should be considered a high priority as it provides the highest level of safety by reducing certain types of collisions. Additionally, it can improve traffic flow and train operations by decreasing travel delay time for both trains and vehicles.

The decision of whether a railroad crossing could be eliminated or improved is closely related to safety, economic, and operational considerations. In determining whether or not to eliminate a crossing, the cost of retaining the crossing must outweigh the cost of providing an alternative access. Federal regulations declare that all crossings with full control of access on highways must be eliminated regardless of the traffic volume on road and railroad. State departments of transportation (DOTs) and local officials develop their own criteria based upon local conditions when considering whether to close potentially redundant crossings. Some common funding resources for crossing closure include states' incentive programs or railroad's participation [1].

A mixture of political and economic obstacles often affects the decision-making process for closing crossings. Overcoming these obstacles require a set of tools from forceful

laws to community engagement in order to overcome local resistance to the closure. To evaluate the most efficient alternative, local communities along with state authorities should compare the cost of retaining the crossing against the cost of providing alternative access. The cost-benefit analysis compares elements such as collision costs, improvement cost, and traffic growth rate to determine the opportunity of closure for each crossing. There is no single way for risk evaluation and priority practices that is used by every state. Some states, such as Pennsylvania, use FRA's GradeDec.net and others use railroad-supplied data or state crash records, such as New Jersey and Ohio [7]. The handbook *Railroad-Highway Grade Crossing*, prepared by the Federal Highway Administration (FHWA) of the United States Department of Transportation (USDOT) (2007), includes a holistic approach on cost-benefit analysis for crossing closure projects [1] [8]. Identification of crossing candidates for closure or grade separation requires a system approach and demands rail operation professionals, traffic and safety engineers, and road designers. Some states apply Benefit-Cost Analysis (BCA) to evaluate the efficiency of their projects, monetize indirect costs such as delay (e.g., North Carolina), or rank safety improvement projects (e.g., California, Wisconsin) [7].

The selection process of closure employs external factors and rating formulas to determine the best suited crossings for closure and potential alternative roads. One review of national and states' reports on candidate evaluation shows that common criteria for the selection include traffic conditions, alternative access, and crossing geometry [9]. Another study identified a combination of transportation [e.g., Average Daily Traffic (ADT), train speed, road type, accident history]; economic [e.g., operation cost, construction cost]; social [e.g., land use, crime, social cohesion); and environmental factors [10]. In 1993, the first state-level closure program began in North Carolina Department of Transportation (NCDOT), where 300 crossings were closed by 2017. The criteria considered by NCDOT included the distance between crossings, geometry, collision history, land ownership, land use, available funding, etc. [8]. Likewise, Kansas, California, and Texas utilized different rating formulas to recognize the crossing closure candidates. The common shortcoming of these studies is that they often fail to capture non-transportation and non-financial factors. One academic study in Iowa developed social metrics and computed them by measuring distance to school and proximity to emergency medical service to determine crossing closure suitability [9].

The other way to reduce redundant crossings is consolidation, which refers to the diversion of traffic from an unneeded crossing to an adjacent one with an upgraded traffic control condition. Even though consolidation is known as a cost-effective and

environmental-friendly alternative, it may decrease social cohesion and deteriorate street accessibility. Strong justification is needed to encourage communities to support crossing consolidation. Lessening environmental pollution, consolidation impact, collision, traffic fatalities, improvement in safety, and quality of life are instances of non-monetary incentives which justifies removing redundant crossings [11].

Objective

The objectives of this research included the following:

- Investigate the (both publicly and privately owned) crossing status in the state of Louisiana, including working with Louisiana Department of Transportation and Development (DOTD) to obtain the existing data and information
- Conduct a thorough and comprehensive literature review to summarize the current knowledge and practice in the literature
- Outline the funding sources (such as FHWA and FRA) and programs for improving grade crossing safety
- Conduct a state-wide survey and interview of stockholders to better understand the concerns, barriers, and solutions particularly in Louisiana, including but not limited to state and local transportation departments and agencies, railroad companies, and rail users in Louisiana
- Identify incentive programs already being used and potential new programs that offer promise in reducing the number of crossings in Louisiana
- Develop a model that can predict the priority rating of individual crossings for closure or other decision making

Scope

The ultimate goal of this research was to identify the effectiveness of existing incentive programs and/or new programs for closing railroad grade crossings in Louisiana. To achieve this goal, researchers employed several tools, including literature review, survey, and interview. A comprehensive literature review was conducted through searching TRID database, Google Scholar, ScienceDirect, Web of Science, Google general search, etc. Any online materials that are related to crossings were included, including but not limited to academic publications, technical reports, news articles, etc. However, researchers limited literatures to the United States considering the context of this research's goal. Researchers also limited the data collection of the survey and interview to Louisiana with the same reason.

Methodology

In order to provide recommendations on incentive programs for crossing closure, this research employed two methods—review and synthesis as well as survey and interview.

Literature Review and Synthesis

Transportation professionals often face problems in their day-to-day work. The potential solutions may already exist either in documented form in research or as undocumented experiences in practice. However, this information is often fragmented, scattered, and unevaluated. Therefore, full knowledge of what has been learned about a problem is frequently not brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. To provide a systematic means for assembling and evaluating such useful information together and making it available to the entire highway community, it is critical to search out and synthesize useful knowledge from all available sources and prepare concise and documented reports on specific topics. A review and synthesis reports on current knowledge and experiences in the literature and practice. It provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. It collects and analyzes available information assembled from numerous sources to 1) locate and assemble documented information, 2) learn what practice has been used for solving or alleviating the problems, 3) identify all ongoing research, 4) learn what problems remain largely unsolved, and 5) organize, evaluate, and document the useful information that is acquired.

For this research, a comprehensive literature review was conducted through searching TRID database, Google Scholar, ScienceDirect, Web of Science, Google general search, etc. Any online materials that are related to crossings were included, including but not limited to academic publications, technical reports, news articles, etc. However, researchers limited the literatures to the United States considering the context of the goal in this research. Researchers also limited the data collection of the survey and interview to Louisiana for the same reason. This final report is the product of a review and synthesis that is an immediately useful document for policy making and practice.

Survey and Interview

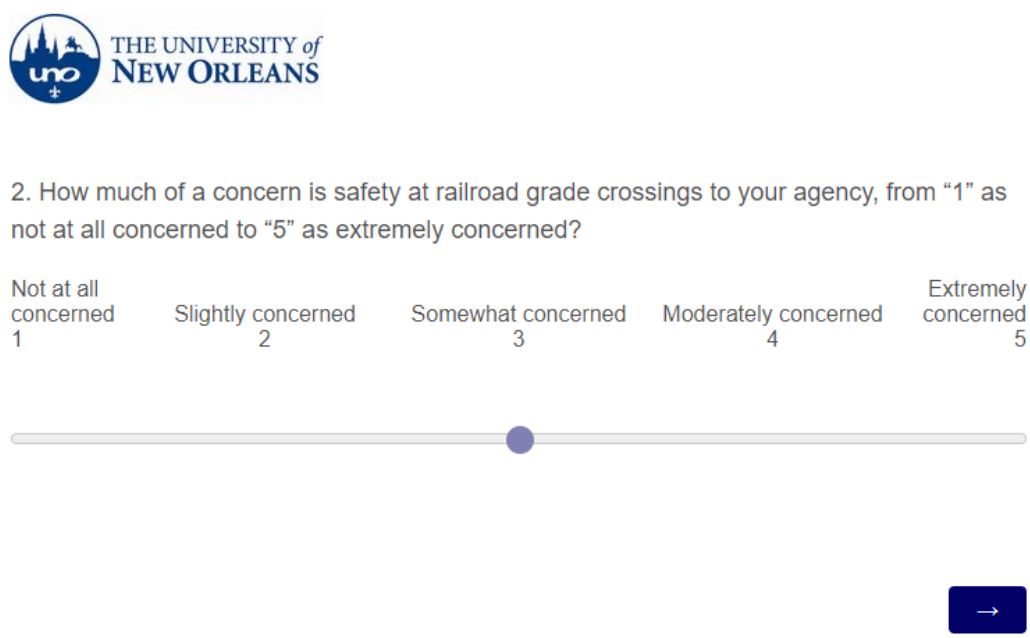
Survey Design

The main themes of the survey were safety and other concerns related to crossings as well as existing programs and their effectiveness for the closure of crossings. The survey questions were designed based on the knowledge from the literature review. The main questions in the survey included:

- How much of a concern is safety at railroad grade crossings to your agency, and are there any other issues at railroad grade crossings concerning your agency?
- Do you support closure of railroad grade crossings to reduce your agency's concerns?
- Does your agency offer or administer any incentive programs for the closure of railroad grade crossings? How would you rate the effectiveness of the programs?
- If you are interested in being interviewed, please provide your contact information.

See Appendix A for the complete survey. Figure 2 shows a screenshot of the final appearance of the survey. The survey was designed and administrated by using Qualtrics platform, which is an online survey tool that is widely used in research.

Figure 2. The final appearance of the survey



Survey Distribution

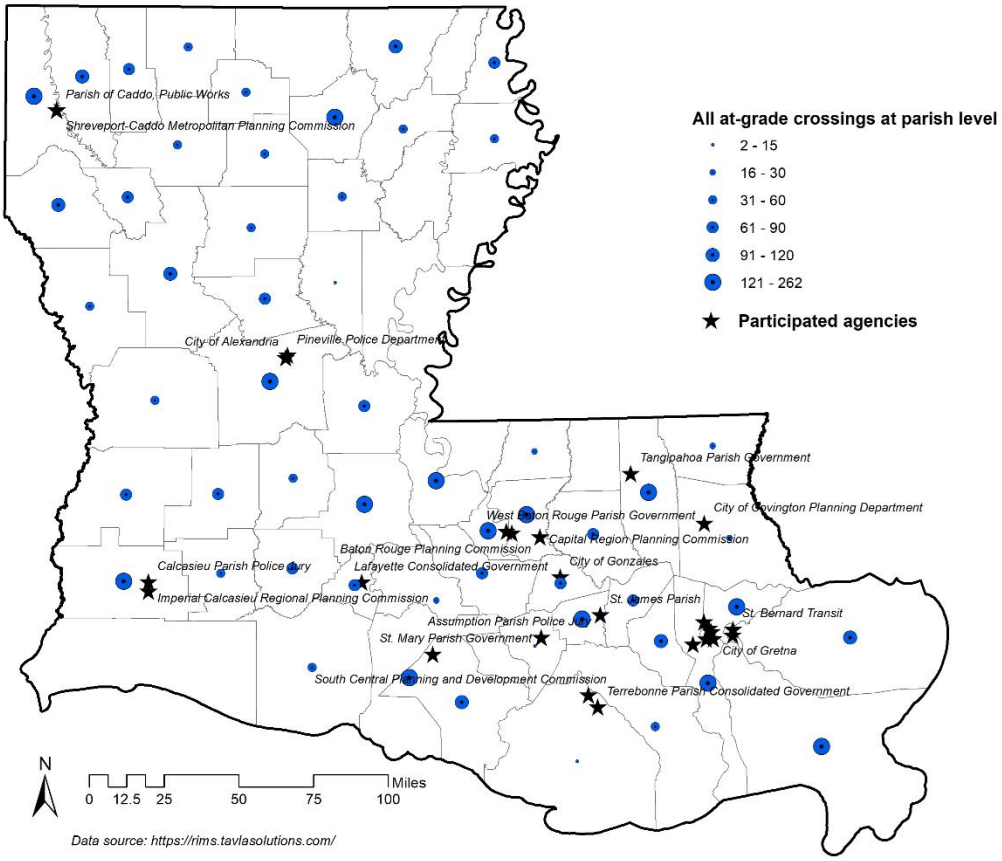
The survey was intended for people who have knowledge of railroad grade crossings from their professional experience as employees of public state/local agencies or railroad companies. Researchers started with portals of cities, parishes, and state agencies to develop a contact list of transportation professionals and planners across the state of Louisiana. Due to the constraint of time and recourses, cities were limited to those with 5000 or more population, and parishes were limited to those with railroad tracks passing through their jurisdictions. As a result, researchers collected contact information of 344 personals from 145 agencies, including eight Metropolitan Planning Organizations (MPOs), 56 cities, 49 parishes, and 32 related professional agencies. Between July 21 and August 24, researchers reached out the 344 personals via email and invited them to participate in the online survey. The survey was accessible through both desktop computers and mobile devices. To recruit as many agencies as possible, emails were sent in two rounds. There were 221 emails sent to two or three staff of each agency in the first round, and 132 emails were sent only to the staff of those agencies that did not respond in the first round.

Interview

In the survey, the participants were asked whether they were also willing to participate in an interview and nine of them expressed their interests. After sending an invitation for the interview, six persons were scheduled with a 45-minute online (Zoom) interview between August 25 and September 2. Due to Hurricane Ida, some of the interviews were rescheduled in late September.

At the end, there were 39 meaningful survey responses (with answers to the main questions) of out 63 responses and six interviews. These responses came from 30 different agencies across public and private entities, MPOs, city and parish governments, planning commissions and policy departments, etc. See the full list of the agencies in Appendix B. Although researchers were unable to get any personnel from railroad companies to participate in this study, researchers did find railroad companies' policies related to rail crossings from online sources and previous studies, which were shown in the following result section. Figure 3 shows the distribution of survey responses. While researchers did not have responses from every parish or city that has crossings within their jurisdictions, the participated agencies are across the state. Particularly, researchers had more participants in the south and southeast parts of the state, where both rail crossings and population are more concentrated.

Figure 3. Agencies participated in this research



Discussion of Results

Overview of Crossings in Louisiana

The investigation of the crossing status in Louisiana was based on data from the Research Information Management System (RIMS). As of 2021, there were 9,077 crossings in Louisiana. Of which, 5,534 crossings are currently active and 3,543 crossings are inactive or closed. Among the active crossings, there are 3,173 public crossings, 2,353 are private crossings, and eight are unclassified crossings. There could be more private crossings that are not included in this database. The majority (92%) of these active crossings are at-grade crossings.

Table 1. Overview of crossings in Louisiana

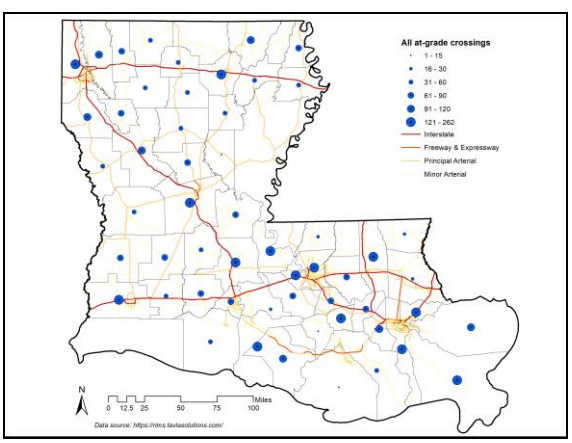
<table>
<tr><th>Total</th><th colspan="2">Inactive</th></tr>
<tr><td rowspan="8">9,077</td><td colspan="2">3,543</td></tr>
<tr><td>Active</td><td>Public</td></tr>
<tr><td rowspan="6">5,534</td><td>3,173</td></tr>
<tr><td>private</td></tr>
<tr><td>2,353</td></tr>
<tr><td>At-grade</td></tr>
<tr><td>5,106</td></tr>
<tr><td>Grade separation</td></tr>
<tr><td>428</td></tr>
</table>

Note: data source – Research Information Management System

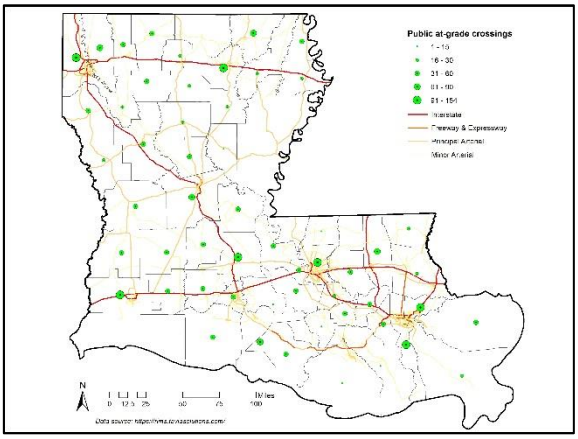
The maps in Figure 4 show the spatial distribution of different types of active crossings by parishes. They are all over the state and some parishes have more certain crossings than others. The top five parishes with more than 200 at-grade crossings are Jefferson, Orleans, East Baton Rouge, Calcasieu, and Plaquemines. The top five parishes with public at-grade crossings are Calcasieu, East Baton Rouge, Caddo Parish, Ouachita, and Orleans. The top five parishes with private at-grade crossing are Plaquemines, Jefferson, Orleans, St. James, and East Baton Rouge. There are also grade-separated crossings in the state with the top five parishes as Caddo, Orleans, Rapides, East Baton Rouge, and Jefferson.

The map in Figure 5 shows population that lives close to active at-grade crossings in Louisiana. As of 2020 census population, 45.7% of the total population in Louisiana lives within one mile of an active at-grade crossing. 74.1% of the state's population lives within three miles of an active at-grade crossing.

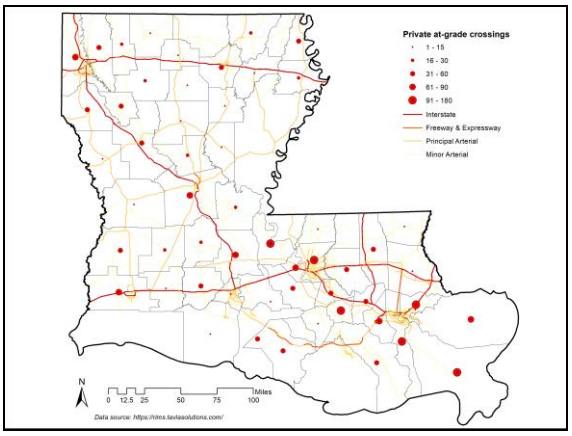
Figure 4. Different types of active crossings by parish



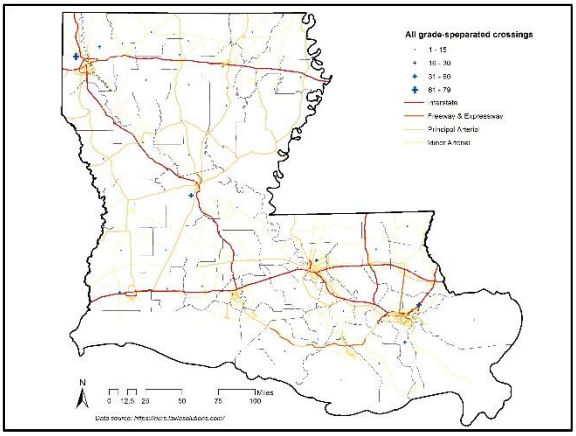
(a) All at-grade active crossings



(b) Public at-grade active crossings

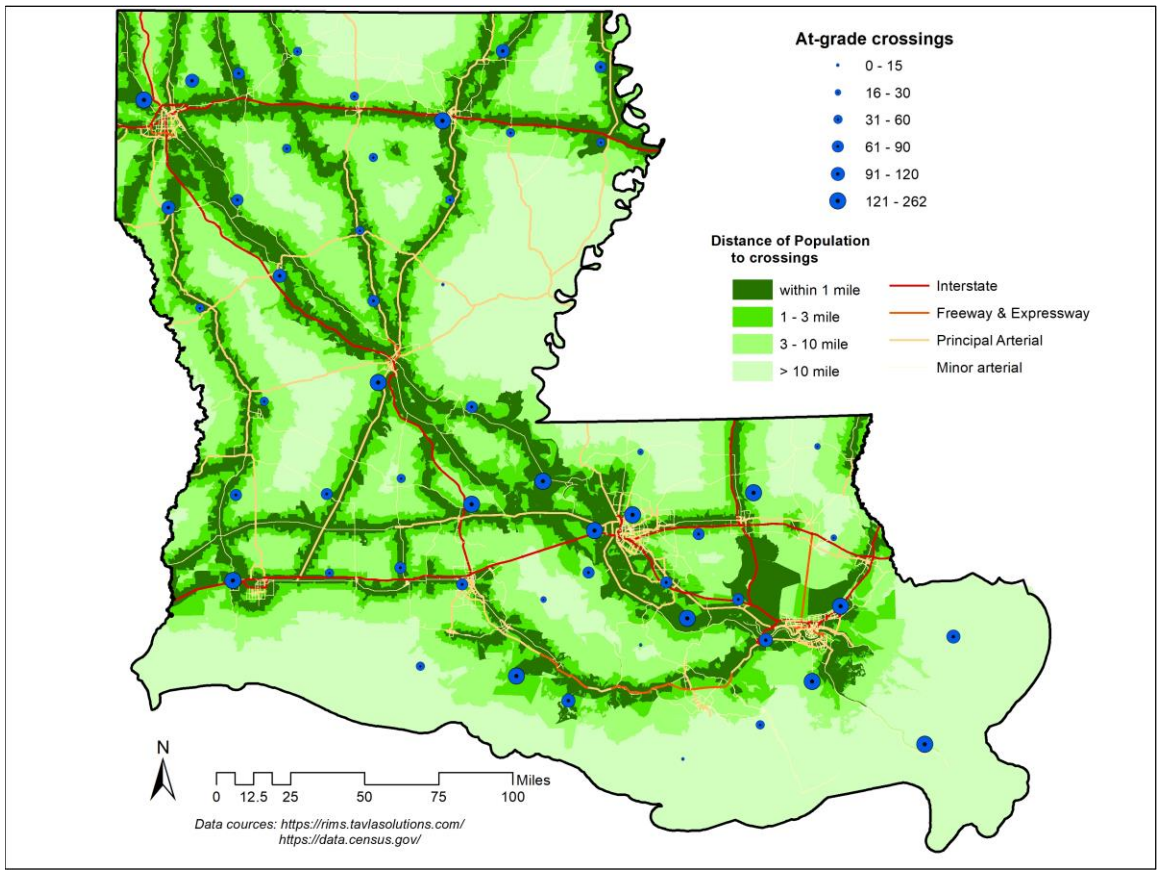


(c) Private at-grade active crossings



(d) Grade-separated active crossings

Figure 5. At-grade crossings and population



Existing Programs and Their Effectiveness

Findings in the Literature

Based on a nationwide survey from state departments of transportation (DOTs) and railroad agencies, Codjoe [11] recognized five types of incentive programs that were applied for road-railroad crossing closures across the country. Table 2 summarizes their description, popularity, and effectiveness. Popularity is the number of states that reported offering the incentive program in the survey. Effectiveness is a likert scale of 1 (least effective) to 5 (most effective) that respondents rated the effectiveness of each incentive program in the survey.

Cash incentive program is usually affiliated with federal-aid programs under the federal Section 130 program, offering up to $7,500. It is good to utilize the federal funding and support. However, the amount from federal contribution is not sufficient and it requires states' effort in providing the remainder. It was offered by 10 states and ranked as the least effective program in the survey.

Road improvement program aims to provide road improvements and connectivity in the area in order to mitigate some of the undesirable results of crossing closure, such as traffic congestion, rerouting, etc. It was offered by six states and ranked as the second least effective program in the survey.

Nearby crossing grade separation would be a great program in the theory, as it was ranked the second most effective program in the survey. However, in reality, it seems like an impractical approach due to the high cost of building bridges and underground passes. That is probably the reason that there are only five states that offered this incentive program.

Nearby crossing improvement programs are a form of improvement-based programs that aim to minimize traffic congestion via crossing consolidation. Its effectiveness was ranked moderate among the five programs in the survey with a high popularity. There are 10 states that offered this program.

Track relocation program aims to switch operation away from congested locations. It is considered as another impractical program due to the high cost. Although it was ranked as the most effective program in the survey, track relocation was the least popular program with only four states what offered it.

Table 2. Incentive programs [11]

Program Name	Description	Popularity	Effectiveness*
Cash incentive	This program is usually affiliated with federal-aid programs under the federal Section 130 program, offering up to $7,500.	10 states	1
Road improvement	This program provides road improvements and connectivity in the area to mitigate the undesirable results of crossing closure.	6 states	2
Nearby crossing grade separation	This program provides grade separation crossings nearby as an alternative of crossing closure.	5 states	4
Nearby crossing improvement	This is a form of improvement-based program aimed to consolidate the overall crossings.	10 states	3
Track relocation	This program aims to switch operation away from congested locations.	4 states	5

Note: *1 – least effective and 5 – most effective

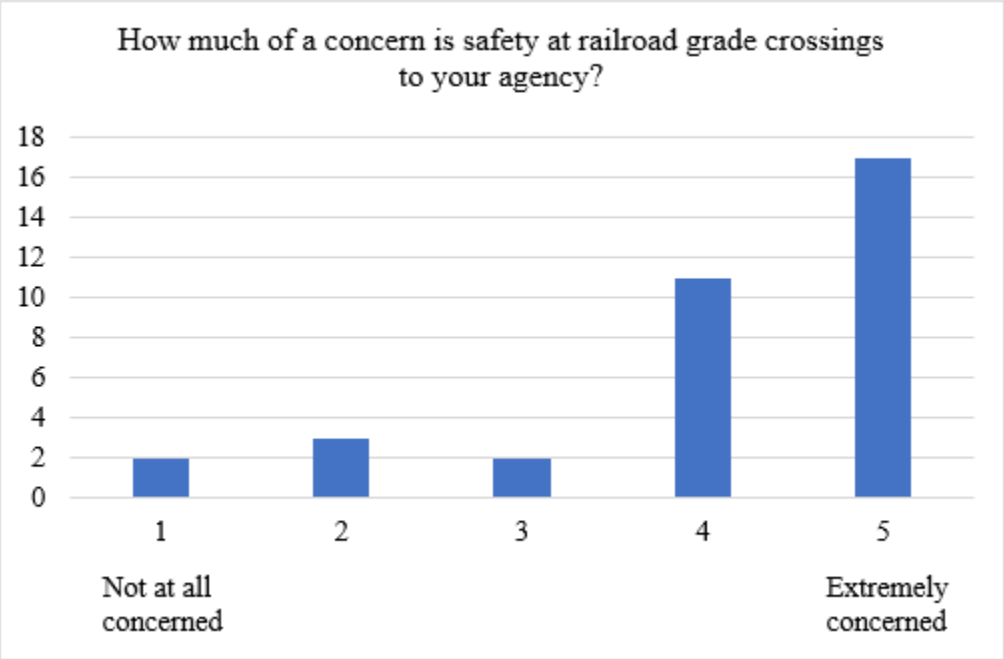
Overall among these programs, cash incentives and nearby crossing improvements were the most popular incentive programs for at-grade road-railroad crossings. In contrast, the track relocation and nearby crossing grade separation were the least popular programs due to their high cost of implementations. In terms of effectiveness, track relocation and nearby crossing separation were ranked as the most effective programs, while cash incentive was the least effective. There is a conflict between popularity and effectiveness due to cost. The study also found that states with any incentive program had higher proportion of at-grade crossings closures. The study concluded that the combinations of multiple incentive programs would be more effective. For example, track relocation with other types of incentive programs except cash incentive leaded to almost half of crossing closure across the country. Cash incentive with other types of incentive programs except track relocation, generated 40.8% of crossing closures.

Louisiana was included in Codjoe's study. The Louisiana Department of Transportation and Development (DOTD) did not report any incentive program, while BNSF railway stated offering a form of incentive. BNSF has an improvement-based incentive program for closure of crossings and nearby crossings as well.

Findings from the Survey

Safety. For the first question regarding to safety at crossings, 49% respondents expressed that their agencies were extremely concerned about the safety at railroad crossings and 31% respondents expressed that they were moderately concerned. There were 6% respondents expressed that safety was not a concerned to their agencies at all. Overall, safety at crossings is a concern to the super majority of respondents.

Figure 6. Safety concern

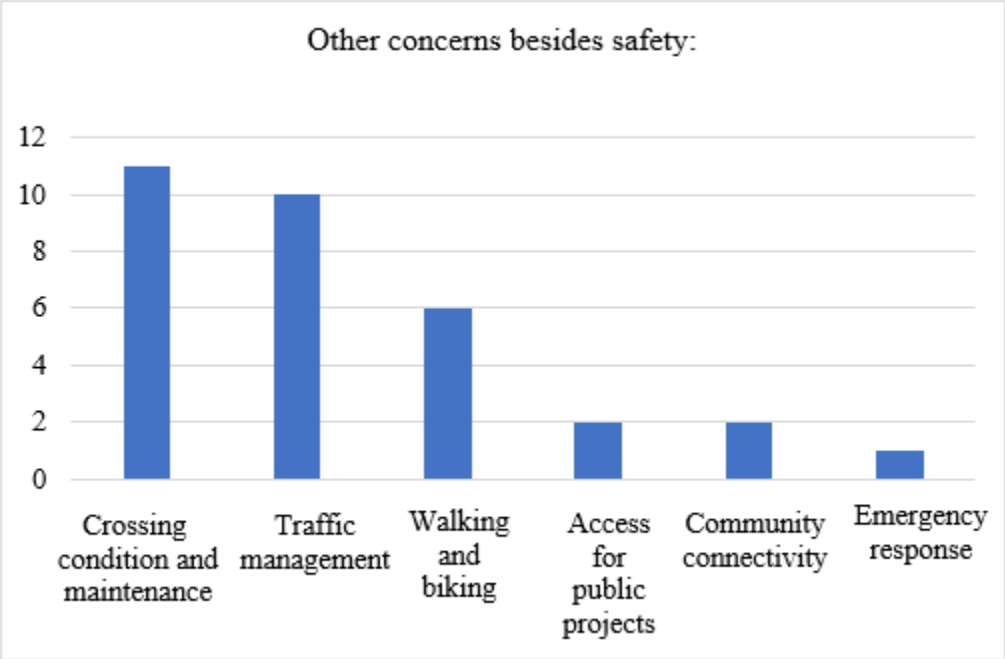


Other Concerns. When asked what other issues at railroad crossings were concerning their agencies beside safety, respondents provided wide range of answers. These answers were summarized into the following categories with frequencies they were mentioned:

- The condition and maintenance of crossing surface and equipment, mentioned 11 times;
- Traffic management (efficiency, congestion, interruption), mentioned 10 times;
- Access for pedestrians and cyclists (such as sidewalk, bridge, etc.), mentioned 6 times;

- Access for public utilities and permission of railroad right-of-way for public projects, mentioned 2 time;
- Community connectivity and revitalization, mentioned 2 times; and
- Emergency response, mentioned 1 time.

Figure 7. Other concerns

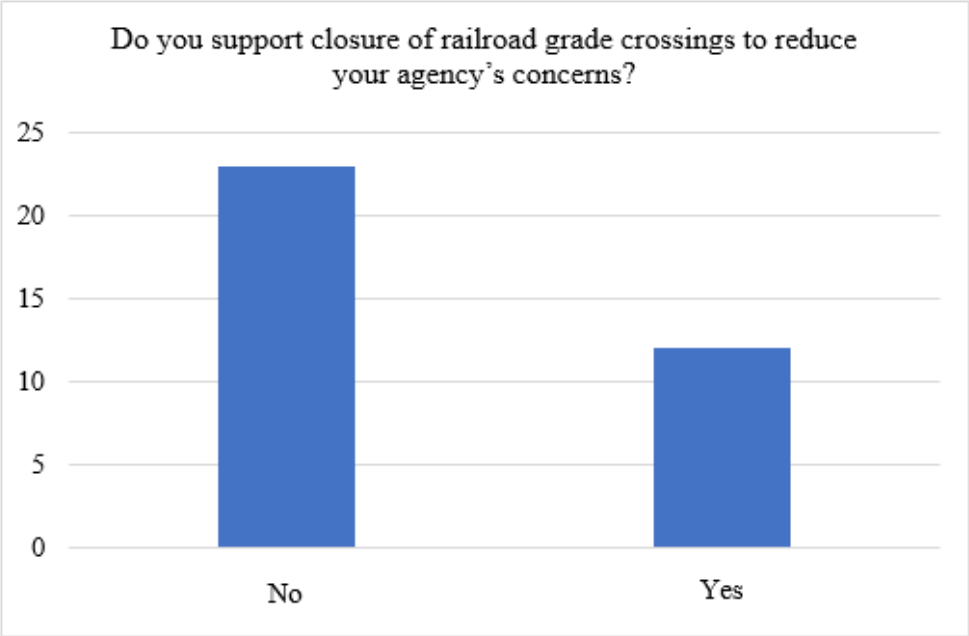


Besides safety, the three primary concerns were the condition and maintenance of crossing-related facilities and traffic management and access for active transportation. Specifically, respondents expressed their concerns about the poor condition of crossing surface and the maintenance of signage, equipment, and other devices, which may cause safety issue in the long term. They were also overwhelmingly not satisfied with the traffic management at crossings by citing traffic congestion, traffic flow interruption, high volume of trains, etc. The next major concern was lack of access for pedestrians and cyclists passing crossings. A few respondents demanded sidewalks and bridges at crossings for walking and biking.

In addition, respondents mentioned that it was hard or time-consuming to get access to railroads for utilities, sidewalks, road improvements, and other public projects. It could take 1-2 years to get permissions in and around railroad right-of-ways.

Closure Support. The previous questions show there are safety and other concerns related to crossings. However, there was only one third of respondents supporting to close crossings as the mean to reduce their concerns. The comments from one particular respondent may provide some insight. They explained: "1) the railroad made those agreements with agencies and land owners long ago to allow for the railroad to be placed; 2) reducing the number of crossings forces that traffic to other crossings; 3) the use of these crossings by emergency vehicles is imperative; 4) the closure of these crossings is an unsightly mess."

Figure 8. Closure support



Incentive Programs. All, expect one, respondents said their agencies did not offer or administer any incentive program for the closure of railroad at-grade crossings. For the respondent whose agency did offer incentive programs, "nearby crossing grade separation" and "track relocation" were offered or administered. Both were ranked as very effective. The respondent said these programs helped the traffic for the road and saved the railroad companies money in equipment and labor, and they were the safest ways as well.

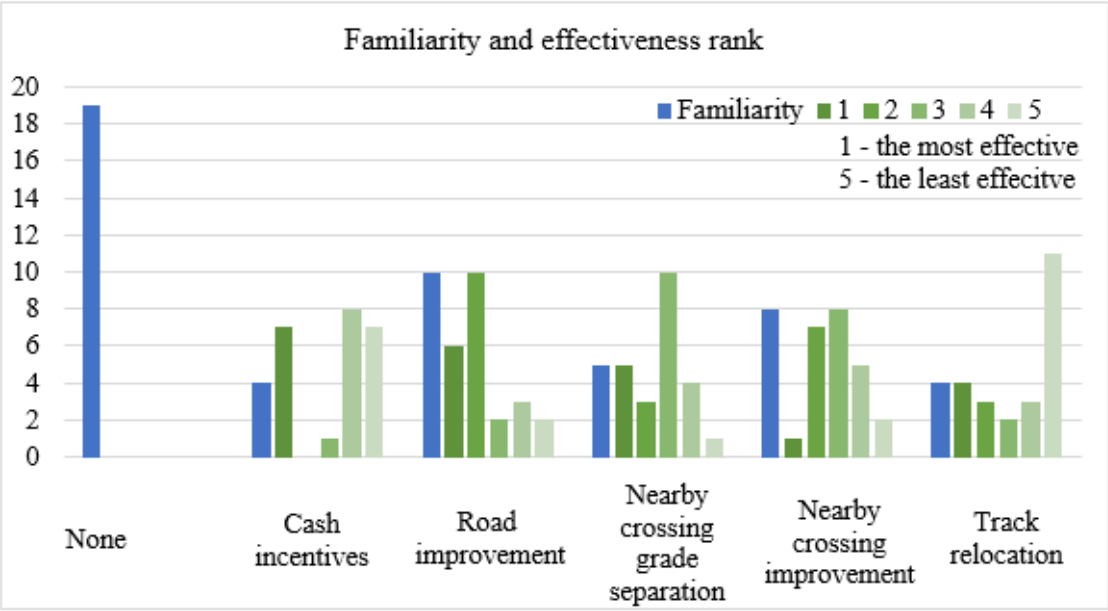
Nineteen out of the 33 respondents have not heard any incentive program before. For the rest, they were mostly familiar with "road improvement" and "nearby crossing improvement" and less familiar with the other three programs. Most of the respondents

did not have any experience with the actual effectiveness of these programs. So, they were asked about how they would rank these programs in terms of effectiveness on closure of railroad at-grade crossings with "1" as the most effective and "5" as the least effective. The result shows that "road improvement" was ranked as the most effective program and "track relocation" was ranked as the least effective program. The rank of all five programs are:

- 1st: road improvement
- 2nd: nearby crossing grade separation
- 3rd: nearby crossing improvement
- 4th: cash incentives
- 5th: track relocation

It is worth to notice that "road improvement" is the most familiar program among the respondents and ranked the most effective program. There could be a correlation between respondents' familiarity with the programs and how they ranked them in terms of effectiveness.

Figure 9. Familiarity and effectiveness rank of incentive programs



Respondents were also asked to provide any other effective ways to address their agencies' concerns at railroad at-grade crossings. The answers were summarized into the following categories:

- Providing intelligent transportation system (ITS) to inform the public of blockages to allow detour routes on appropriate roadways;
- Improving the design of crossings for safety and visibility with lights, signage, warning technologies;
- Public and community engagement, behavioral education outreach;
- Better communication/contacts with the railroad companies;
- Improving safety measures for non-motorized users;
- Scheduled railroad use at particular off-peak times throughout day;
- Increasing railroad responsiveness and cooperation in maintenance efforts; and
- Federally funded grade separation efforts.

Findings from the Interview

Through the online survey, researchers invited 145 different agencies across the state of Louisiana to participate in an open interview for further discussion about concerns, suggestions, and thoughts on safety of at-grade railroad crossings. Ultimately, researchers were able to schedule interviews (through Zoom) with six professionals who shared their opinions. While the invitation was distributed across different agencies, researchers received responses from agencies of urban areas, mostly located in New Orleans and Baton Rouse. The agencies they represented were City of New Orleans (NOLA), Greater New Orleans (GNO) Regional Economic Development, Jefferson Parish Economic Development Commission (JEDCO), New Orleans Public Belt (NOPB), Operation Lifesaver (OL), and Regional Transit Authority (RTA).

Digging into the content of the interviews, researchers found several major themes including regulation, technology, policy, public engagement, and funding. In the following, researchers summed up the perspectives of interviewees on those subjects. Regarding the closure of railroad at-grade crossings, there have been three different standpoints.

Regulation and law enforcement are protective tools, and state and local agencies can prepare regulatory plans based upon the safety needs of their communities. For example, state DOTD and RTA provide plans for passenger/heavy railroad and streetcars throughout the state of Louisiana, which mandate roadway and railroad operations to follow these regulations. These regulations could be intensive technical tests or active warning devices, such as gates and arms or gates and lights to communicate with people. Technology, such as electronic signs and flashing lights, has been improved over the last 30 years and helped to increase the safety and efficiency of railroad crossings.

A good transportation policy makes the transportation network more resilient. It involves all stakeholders, gets their voice heard, and considers concerns of all parties including traffic safety engineers, railroad companies, nearby communities, and landowners. In some communities, railroad tracks are barriers that cut off neighborhoods from one to another, and that is one reason that local communities have hesitation to close some existing crossings. Local communities are strong impediments to crossing closure projects because that may limit their mobility or decrease their social cohesion. Especially, there is a coherent sense of being a single neighborhood at both sides of a track. A good transportation policy also has to be context-sensitive, not one size fits all policy statewide regardless of land development patterns and local contexts. The approaches that are taken in an urban area, a suburban area, and a rural area should be very different. Also, communication with local communities before taking any final action is critical because communities are strongest impediments in such projects.

All interviewees unanimously emphasized the significant impact of education on safety improvement. Both railroad operators and the public need training and awareness. When passing a crossing, impatience and carelessness come from human nature, and thus, transportation planners must target these risky behaviors and try to change them through education. OL is actively working on increasing awareness, training, and education of different parties. At the time of the interview, they were holding national rail safety week. Inter-agency collaboration on safety outreach material recently led to a grant awarded to OL and RTA jointly. OL uses a variety of tools from media and billboard advertisement to public meetings, driver training, and school education to pursue its goal of achieving zero crashes and fatalities.

Different parties may possess conflictual perspectives on the closure of at-grade crossings depending on their immediate or long-term benefits. On one hand, freight railroad companies want safer, faster, and more frequent operations and, therefore, are supportive to close as many crossings as possible. On the other hand, residents are not receptive of

heavy railroads and the noise of train horns to their community. They do not want to burden the extra travel distance to bypass around a closed crossing. The interviewees brought up three different viewpoints based upon their specialties and concerns. Interviewees from NOPB and OL fully supported closing redundant crossings as long as it makes the environment safer for the public. In contrast, the interviewee from NOLA did not suggest closing a crossing as the first alternative. Instead, the interviewee suggested that all other scenarios should be thoroughly explored, and it was the necessary way to achieve a safety goal by considering every other alternative before closing a crossing. Interviewees from JEDCO and GNO were not directly involved with railroad safety crossing issues, thus they did not provide any explicit comment on the question whether they support closure of redundant at-grade crossings. But they were optimistic that DOTD could find mechanisms and structures that would allow efficiency for traffic flow of end users of railroads as well as the residents who live around.

Other Programs for Crossing Closure

Programs in Other States

The FRA mandates 10 states with the most at-grade crossing collisions to produce and submit a Highway-Railroad Grade Crossing State Action Plan (SAP) in order to allocate financial resources for improvements that bring higher levels of safety. SAP typically includes data analysis, strategies, and implementation in short- and long-term.

California. Grade-crossing projects are expensive, and the funding sources are limited. California uses a variety of federal, state, local, and railroad companies' financial resources and continues expansion of the federal Section 130 program and the State Section 190 Grade Separation Program [12].

California Department of Transportation (Caltrans) provides 100% funding for Railroad Highway Grade Crossing Program (RHGCP), which consists of 90% federal contribution and 10% local match that also receives Caltrans funds. Section 130 matches a crossing closure incentive up to $7,500 to a local agency. The RHGCP is a coordinated program between FHWA, Caltrans, California Public Utilities Commission (CPUC), railroad companies and local agencies [13]. However, this amount is not considered as a sufficient incentive for local governments who face political pressures from communities against crossing closures [13] [14].

Florida. Florida receives $80 million annually through Highway Safety Improvement Program (HSIP), which provides 90% of federal funding share. Only a small portion of this amount is spent on the State Highway-Rail Grade Crossing Safety Improvement Program. The Surface Transportation Program (STP) is a general grant program with the federal share of 80%. It is available for some purposes including crossing eliminations [15].

Indiana. The Indiana Department of Transportation (INDOT) offers the Crossing Closure Program, a one-time incentive payment grant, as part of the Railroad Grade Crossing Fund (RRGCF). INDOT encourages communities to use this incentive to permanently close at-grade crossings. The state legislature established this program to provide funding for railroad-highway crossing improvement projects throughout Indiana. During a fiscal year, a local agency can receive incentive ranges from $20,000 to $50,000 to close one at-grade crossing and $10,000 for subsequent crossing closures. The local agency has

discretion to use the grant on any projects they choose. Each crossing closure project also receives an incentive fund of $5,000 through the Section 130 program [16].

Indiana invested over $3 million in 150 at-grade crossing projects, which valued more than $4 million when adding local contributions. Less than 10 percent of the fund were allocated for crossing closures, barriers, and lighting. The Crossing Closure Program is considered as part of the RRGCF. Communities can receive $10,000-$20,000 for closure [17].

Texas. Two programs are available for funding elimination of redundant at-grade road-railroad crossings in Texas: Federal Signal Program (FSP) and Basic Closure Program. FSP offers up to $150,000-$200,000 to the local authorities to close crossings and improve safety in the area. This fund is available for spots that are highly ranked and selected by Texas Department of Transportation (TxDOT) for crossing safety improvement under the Section 130 program. Any additional cost may be covered by the associated railroad company. In cases where TxDOT does not approve a crossing closure that is selected by local officials, the basic closure program is appropriate. This is a limited fund ($7,500), which requires matching funds from the operating railroad company [18] [19] [20].

Illinois. Some states are supplementing Section 130 through funding set-asides that have been established by state legislatures. For instance, Illinois supplements the Section 130 program with state gas tax revenues to assist Grade Crossing Protection Fund (GCPF). The money is spent on crossing improvement projects, including closures, along local roadways. Crossings located on state roadways are funded through federal programs. Local authorities receive up to $12,000 for the cost associated with the crossing closure. In addition, funds collected from fuel tax along with local match funds can be used for crossing surfacing [7] [21].

Iowa. Iowa utilizes a set of funding opportunities to improve grade crossings, such as closure as part of the Grade Crossing Surface Repair Program, closure incentives from Section 130 program, decreasing reallocation of Section 130 funds, and crossing improvement as a part of establishing new passenger rail. The Section 130 program in Iowa Department of Transportation (Iowa DOT) receives $4.5 million annually to eliminate hazards of at-grade crossings. Of this amount, one million dollars are being directed to the Grade Crossing Surface Repair Program. But over the past decade, the state has decreased a substantial portion of these reallocation [22]. In Iowa, the Federal-

Aid Highway/Rail Crossing Safety Program pays 90% of improvement cost including crossing closures. Projects receive priorities based upon their benefit-cost ratios [23].

Other States. North Carolina began its state-level crossing closure programs in 1993 and recorded its 300th crossing closure in 2017 [8].

Georgia Department of Transportation (GDOT) uses Section 130 Program to match up to a $7,500 incentive offered by some Class I Railroads (CSX Transportation and Norfolk Southern (NS) railway) to a Local Authority to eliminate public crossings [14]. To be eligible to receive this crossing closure funding, GDOT requires local authorities to submit a formal resolution declaring qualified crossings as well as documentation that the action taken to close the crossing occurred through a public process. Since railroad companies can receive financial and operational benefits (e.g., reduced maintenance cost, decreased delays in rail service) from the closure of crossings, they often volunteer to participate in such projects. Once a railroad offers an incentive to local authorities to eliminate a crossing, GDOT uses Section 130 incentive to match up that amount [24] [8] [14].

Michigan Department of Transportation has an on-going initiative as a part of The Local Grade Crossing Program by providing local authorities with an incentive between $50,000 and $150,000. The characteristics of eligible crossings are based on Local Grade Crossing Program's evaluation criteria [25].

Programs and Projects in Louisiana

There are about 5,106 at-grade railroad crossings in the state of Louisiana, from which 2,333 are private road/driveway crossings. The state ranked 7th in the top states with highway-railroad incidents by recording 87 collisions, 31 injuries, and six fatalities in 2017. Thus, there is a need to identify hazardous locations and increase safety at at-grade railroad crossings. As of January 2018, Louisiana closed 47 percent of its at-grade road-railroad crossings, which Orleans Parish has the greatest number of closing cases. Three railroad operations-Union Pacific (UP) Railroad Company, Kansas City Southern (KCS) Railway Company, and Illinois Central Railroad Company (ICRC)-possess the highest number of open and closed crossings in Louisiana [11].

Louisiana is among 16 states that no closure incentive programs were reported by DOT personnel and railroad experts [11]. Other states include Maine, Massachusetts, Colorado, New Mexico, North Dakota, South Dakota, Washington, Wyoming, Idaho, Oregon, South

Carolina, Arkansas, Delaware, Virginia, and West Virginia. While some believe the $7,500 incentive given by the federal government via Section 130 is not worth the trouble of facing local political pressures, at least 28 states including Louisiana do not offer this or any other form of cash incentives. In Louisiana, DOTD, BNSF railway, Delta Southern Railroad, and Watco Companies, LLC in Louisiana were surveyed about their available crossing closure programs. Only BNSF offers improvement-based incentive programs for public authorities and private owners to close railroad crossings, while the other three respondents had none. Louisiana Transportation Trust Fund from taxes on motor fuels can be used as a matching share of federal funding on grade crossing projects. The state does not offer any incentive program for closure despite having a high number of highway-railroad incidents. Codjoe [11] identified three potential incentive programs that could be more effective than existing programs and suit the crossings in Louisiana. These programs include crime rate reduction incentives, increasing greenness of vicinity, and using grade crossing consolidation models to justify closure or consolidation.

In Louisiana, tensions occurred between a railroad company and adjacent farmland owners when the company proposed to close some private crossings. Property owners contended that closing crossings would restrict access to their lands and insisted on their right to use the crossings. The Louisiana legislature established an act that prohibits railroad companies from private crossing closure unless the company proves the high burden of the crossing on rail transportation. The railroad company claimed that the state ban on closure is an unconstitutional decision [26] [27].

In most states, the authority to eliminate at-grade crossings is devolved to state-level agencies. In a few other states, the entities such as the public utilities commission are responsible for crossing elimination. Some states support collaborative efforts between state government and local agencies.

DOTD anticipated various short and long-range projects to enhance safety of at-grade crossings through improvement, grade separation, and grade closure. The crossing projects can be an integral part of a larger freight or passenger rail project, an individual low-cost improvement, or a bridge or underpass at problem locations. The following projects, listed in the next table, are short-term plans that encompass grade crossing projects.

Between 2014 and 2018, annual collisions at the highway-railroad crossing averaged at 85 accidents. Overall, 49 crossing fatalities and 217 injuries were reported within five years. The state designed short-term plans to decrease injuries and death associated with

road-highway crossings such as finding the comparative five-year trend of crashes at each intersection, identifying problem locations, conducting engineering studies, finding alternate access to minimize interface between rail and highway systems, using public education programs, and engaging in enforcement efforts [28].

DOTD identifies about $9 million funding per year for crossing improvement projects, which 90 percent has been sourced from federal High Priority Project funding and 10 percent has been sourced from state or local funding. For grade separation projects, DOTD identifies $9 million per year, 80 percent comes from federal High Priority Project funding and 20 percent from state funding [28].

Table 3. Examples of at-grade crossing projects in Louisiana [28]

Project Name	Description	Benefit	Costs & Source
New Orleans Rail Gateway (10 percent in near term, 90 percent in long term)	Initial construction of the project. Cost estimated 10 percent of project needs.	Provides for improved interchange between Class I railroads. Closures of numerous grade crossings provides congestion mitigation.	$480.63M Source: Federal CRISI, CMAC, Rail Line Relocation, PNRS programs; state and local sources; railroad contributions.
NOGC Rail Relocation of New Orleans and Gulf Coast (15 percent in near term, 85 percent in long term)	Railroad tracks south of New Orleans to access new port facilities. Cost estimated 15 percent of project needs.	Provides for multiple crossing closures and more efficient operations.	$43.5M Source: The BUILD and CRISI funds, PNRS, Rail Line Relocation programs.
Baton Rouge-New Orleans Service	Grade crossing improvements and replacement of the Bonnet Carré Spillway bridge.	Provides for enhanced mobility for Louisiana residents by instituting a new rail service on an intercity corridor linked only by highways.	$80.6M Source: local sources; others to be determined.

Project Name	Description	Benefit	Costs & Source
Other Short Line Railroad		Road closures and crossing improvements on lines belonging to the Acadian Railway, the NOPB Railway, the Louisiana Southern Railroad and Port Rail Link at the Port of Lake Charles	$51.5M Source: to be determined.
Multiple Crossing projects	Safety improvement at BNSF, NS, IC, UP, etc. crossings	Enhances public safety	$32.220M Source: federal High Priority Project funding (90%); state and local funding (10%).
Multiple Grade Separation Projects	Bridge or underpass	Eliminates crossing exposure, thus enhancing safety. Will also enhance the capacity of this high-volume roadway.	$30.35M Source: federal High Priority Project funding (80%) and state funding (20%).

Programs from Railroad Companies

Railroad companies can receive benefits from the crossing closure projects through reduced maintenance cost, higher level of safety, and decreased travel delay. These benefits encourage railroad companies to contribute to crossing closure or consolidations, usually in the form of providing matching share and cash incentive [8].

The rail system in Louisiana is operated by six Class I railroads (large railroads) comprising 2,340 route miles in the state. Eighty five percent of total mileage is owned by these six Class I carriers: UP, Canadian National Railway (CN), BNSF Railway, KCS Railway, NS Railway, and the CSX Transportation (CSX) [29]. Likewise, most of the open at-grade crossings are under the operation of those companies. Among them, several companies have established their own programs to support the grade crossings. Each has its own approach and varies by the level of success. The programs offered and actions taken by each of the major rail companies are explained below.

BNSF Railway. Crossing closure is the first treatment offered by BNSF for preventing crossing accidents. BNSF railroad experts were broadly surveyed about the incentive programs they offered crossing improvement [11]. In Louisiana, while DOTD personnel asserted that there was no incentive offered by the agency, BNSF railway stated that they had forms of incentive programs for rerouting of traffic, closure, and consolidation of crossings. According to the BNSF personnel, the incentive funds are available to both public and private road crossings to assist at-grade crossing closure and can be used at the discretion of the owner.

BNSF provides financial incentives for closure or consolidation of nearby crossings. Since starting in 2000, the agency has closed over 3,000 railroad crossings within six years. Most closures involved private crossings since it is easier to make an agreement with property owners than the government agencies. Railroad companies can contemplate by building a road or cash payment to the landowners [26]. According to the BNSF Railway Public Projects Manual, BNSF determines the amount of incentive on a case-by-case basis, which is paid at the final stage when the new structure is complete, and crossing is permanently closed. Additionally, in case a new public crossing is needed, at least two nearby crossings must be closed. The closure procedure for public crossings varies by states. But generally, BNSF works to reach a consensus on closures and then gets the approval from the state commission. Any potential dispute should be resolved by specific state laws. Federal Section 130 program provides funding for such crossing closures. In the case of private crossings, BNSF works with property owners to facilitate the process [30].

NS. Like BNSF, NS Railway opposes opening new crossings and encourages eliminating at-grade crossings where practical. Applicants should submit the application of private road crossing with considering an alternative for that. A $500 non-refundable fee is required, which does not guarantee an approval. NS conducts the transportation review and approval process [31].

CSX. CSX transportation works with FRA and state agencies to encourage communities to close the existing at-grade crossings where possible by providing incentive payments. This is a goal for CSX since the FHWA *Railroad-Highway Grade Crossing Handbook* asserts that elimination is the first alternative for any at-grade crossing. To close a crossing, the community must engage in a study that aims to identify the existing redundant crossings and recognize three active ones [32]. CSX, which represents 60 percent of rail mileage in Florida, pays 100 percent the cost of closure and shares the cost of road improvement at the closure location [33]. In Mississippi, the funding for at-grade

crossing closures come from 35 percent of the railroad fuel tax [34]. In addition, CSX provides 30 percent of costs for the at-grade crossing closure, while the state provides the remaining 70 percent [35].

UP. To support the federal initiative to decrease at-grade crossings, UP has a program of consolidation of multiple public crossings before establishment of a new one. Again, the agency requires the community to engage in a study to identify three or more crossing closures for each new crossing opened [36].

There was no information available for KCS and CN. Since 2000, BNSF established the crossing improvement initiative with the purpose of reducing collisions and fatalities and as of March 2006 closed 3,000 crossings [8].

Funding Sources

Incentive programs could be employed by different administration levels, from federal agencies to state DOTs, local governments, railroads companies, and private industries that rely on rail service. Navigating funding resources and the process of project selection are crucial steps in any transportation project. Advocates should understand the system by identifying which, where, and how impactful funding sources can be accessed. Like other transportation projects, there are usually multiple funding sources for at-grade crossing closures. Choosing among these resources depends on the type of projects and availability of the funds. Additionally, states can maximize federal funding and secure grants for grade crossing improvements by adding these projects to other larger transportation projects. Here are some available funding sources in recent years.

Federal Funding Sources

NHS Designation Act. The National Highway System (NHS) Designation Act, legislated by Congress in 1995, provided 100 percent federal funding to finance costs of closing highway-railroad crossings. The program was replaced by a subsequent act known as Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). Currently, there are three federal funding sources for crossing safety improvements: federal-aid highway funding such as NHS, or STP; Section 130 set-aside funds; and safety programs fund such as HSIP [8].

Most federal funds are state administered. While FRA does not mandate states to offer any specific incentive program, many states utilize their own programs to encourage crossing closure, improvement, or consolidation [8]. A national-level study conducted by Louisiana State University reported that only 22 out of surveyed 38 states use some form of incentive programs for crossing closure [37].

HSIP. The Highway Safety Improvement Program is a federal aid to decrease fatalities and injuries on public roads. The program consists of three main components, one of which is Railway-Highway Crossing Program (RHCP) and legislated under Section 130.

Section 130. Section 130 RHCP, a set-aside from HSIP, launched in 1987, is a form of a cash incentive program offered by the federal government to local communities that are under the impact of closing rail-road crossings. Between 1987 and 2014, the Section 130 program has significantly been associated with decreased fatality at rail-road crossings. Among 22 states that offer incentive programs, the cash incentive program was employed

by only 10 states. Some believe that the cash incentive program is not worth the trouble of public resistance since the monetary payment is only up to $7,500 for each crossing. Advocates against this program argue that the sum is not sufficient to be considered as a reasonable incentive [11]. Crossing consolidations, elimination, and relocation are among eligible activities or the use of Section 130 safety funds.

CRISI. The Consolidated Rail Infrastructure and Safety Improvements Program (CRISI) was authorized by Congress to improve railroad safety, efficiency, and mitigate congestion at both passenger and freight rail chokepoints through crossing improvement or relocation. Twenty-five percent of the grant is directed to railroad infrastructure in rural communities. Additionally, projects with 50 percent of non-federal funding match have the highest selection priority [8].

Rail crossing incidents have remained steady for the past decade, but still account for 97 percent of all fatalities along railroad nationwide. Recently, the U.S. House of Representatives held a hearing to increase the limited budget of grade crossing safety to support the states struggling with high costs of such projects. The hearing proposed a funding increase through Section 130 grants or at least remaining at current level. It was also recommended to increase the closure incentive cap from $7,500 to $10,000 and incentivize states to pack various crossing projects into a single grant application [38].

State Funding Sources

States participate in crossing improvement projects through several tools, like administering federal funds such as Section 130 RHCP. States also finance crossing projects through fuel tax or other available resources. Some states require local agencies or railroad companies to provide the matching for federal contributions. For crossings located on state highways, states may indirectly allocate a set-aside funds for crossing maintenance as a sub-program of a larger project [8].

Local Agency Programs

Local agencies generally have limited sources of funding for reimbursement of costs and matching funds for federal programs, such as projects under Section 130 program. Local governments also contribute to the maintenance and safety studies at crossing locations. San Gabriel Valley Council of Governments (SGVCOG) developed one of the greatest road-railroad crossing programs in southern California [8].

A Framework for Project Selection

The decision to close a crossing is affected by a mixture of political, economic, and social factors that requires a set of tools, from forceful laws to funding and community engagement. To evaluate the most efficient alternative, state authorities along with local communities should compare the cost of retaining the crossing against the cost of providing alternative access. The cost-benefit analysis compares costs of every aspect, such as collision cost, improvement cost, and maintaining cost etc., to determine the opportunity of closure for each crossing. USDOT's *Highway-Rail Crossing Handbook* prepared by FHWA [36] includes a holistic approach on cost-benefit analysis for crossing closure projects. Identification of crossing candidates for closure or grade separation requires a system approach and demands professionals in rail operation, traffic and safety engineers, and road designers. Consolidation and closure modeling employ external factors and rating formula to determine the best-suited crossings for closure and potential alternative roads. A variety of factors are used in the literature, including transportation (e.g., ADT, train speed, road type, accident history); economic (e.g., operation cost, construction cost); social (e.g., land use, crime, social cohesion); and environmental factors [10].

Blocked crossings pose potential safety risks, congestion, and other problems. FRA launched an online portal in December 2019 (https://www.fra.dot.gov/blockedcrossings/) to collect public input to gain a better understanding of the problem. Between January 28, 2020, and October 8, 2021, the portal shows 195 cases reported on railroad crossings blocked by trains in Louisiana. After removing duplicate records, there were 177 cases including 21 moving trains and 156 stationary trains. The trains belonged to nine different companies, of which UP and KCS were responsible for 100 cases of blocked crossings. The blockage of railroads crossing occurred in 33 cities, where Baton Rouge, Bossier City, and New Orleans experienced the highest rate with 25, 20, 15 times, respectively. The duration recorded varies between 0-15 minutes to 6-12 hours. More than 40% of the blockage took between 31-60 minutes and 37% took between 15-30 minutes.

According to the Highway-Rail Crossing Handbook [8], closure criteria comprise a set of technical considerations which can vary by locality. Examples of matters that can be included in selection criteria are traffic volume, speed, location, visibility, number of tracks, number of crashes, distance to traffic signals, and emergency vehicle access. For instance, locations with X number of crossings per mile with less than Y vehicles and

more than Z trains per day are the candidates for consolidation. The handbook recommends a combination of methods and techniques to evaluate and select an alternative for a rail-roadway crossing:

1. a technical working group (TWG) who are crossing treatment experts from FHWA, FRA, Federal Transit Administration (FTA), and National Highway Traffic Safety Administration (NHTSA),
2. a field diagnostic team, conducting field survey procedures by experienced individuals to ensure that site-specific features are considered,
3. cost-benefit analysis,
4. resource allocation model, designed to provide a list of intervention that would lead to the greatest collision reduction, and
5. FRA evaluation software (https://gradedec.fra.dot.gov/), provided for U.S. government-authorized use only, to assist state and local planners in identifying the most efficient closure.

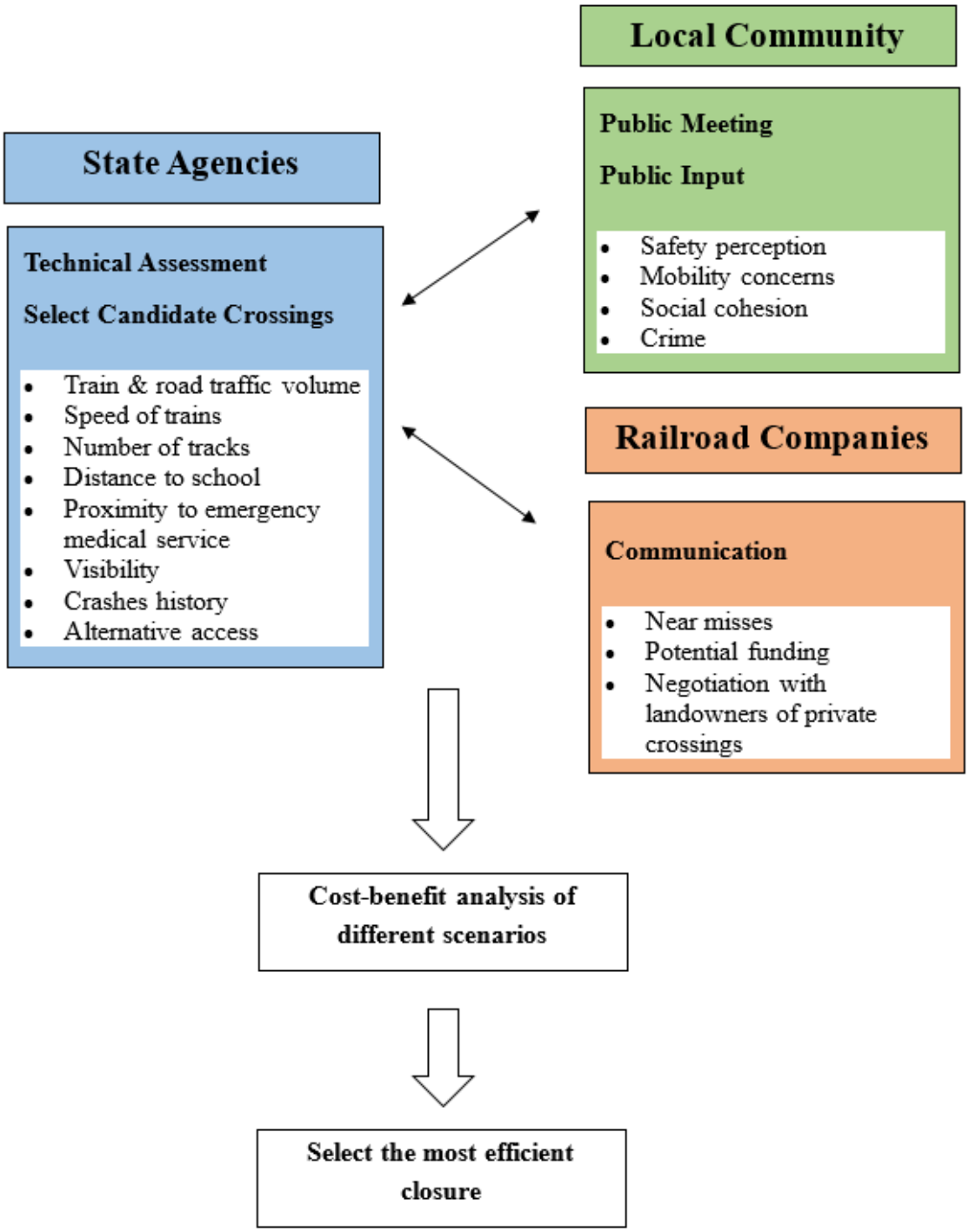
In order to select candidate crossings for consolidation, at least one item from the list below must apply:

- an engineering study identifies a nearby crossing that provides acceptable access for vehicle and pedestrian,
- an engineering study determines any items listed here: average annual daily traffic up to 1,000, alternative access within one mile along the track, and less than 2.5 miles increase in median trip length, or
- when a railroad operation blocks the crossing, and it is not feasible to build a grade separation or relocate the railroad [8].

A crossing consolidation or closure project begins with a list of nominated crossings suggested by the governing agency or other stakeholders. Then, they evaluate multiple crossing locations along the rail line to select the most efficient location based upon safety and mobility considerations. Eventually, the characteristics of the selected crossing are further studied by a technical review team, which is comprised of all stakeholders. Since local community is the strongest impediment in such projects, community engagement is helpful in negotiation stages and decreases the costs of administrative burdens. The NCDOT implemented a successful crossing program, which is a model program for other states. They used three elements of coordination: involvement of state, local community, and railroad; communication to keep the community informed about

the progress; and consistency. Another critical factor in the selection process is whether it is a public or private crossing. Private crossings are unregulated and require negotiation between property owners and railroad companies [39].

Figure 10. A framework for crossing closure selection



Conclusions

As of 2021, there are 9,077 crossings in Louisiana. Of which, 5,534 crossings are currently active and 3,543 crossings are inactive or closed. Among the active crossings, there are 3,173 public crossings, 2,353 private crossings, and eight unclassified crossings. There could be more private crossings that are not included in the state's database. The majority (92%) of these active crossings are at-grade crossings. Meanwhile, 45.7% of Louisiana's total population live within one mile of an active at-grade crossing. And 74.1% of the state's population live within three miles of an active at-grade crossing. There are tons of interactions between trains and road users (automobiles, bikes, pedestrians, etc.) at crossings every day in Louisiana, which create safety risks for the state's multimodal transportation system. Although Louisiana has witnessed a decline in highway-rail crossing accidents in recent years, which mirrors national trends, it is still one of the 10 states that has the highest number of grade crossing collisions on average. This study investigated existing incentive programs in the literature and perspectives of professionals working in this area to help reduce the number of crossings across Louisiana.

In the literature, a national study identified five incentive programs that were offered by other states in the United States. Among these programs, the study found that cash incentives and nearby crossing improvements were the most popular incentive programs for at-grade road-railroad crossings. In contrast, track relocation and nearby crossing grade separation were the least popular programs due to their high cost of implementations. In terms of effectiveness, track relocation and nearby crossing separation were ranked as the most effective programs, while a cash incentive was the least effective. There is a conflict between popularity and effectiveness due to cost. The study also found that states with any incentive program had a higher proportion of at-grade crossings closures. It concluded that the combinations of multiple incentive programs would be more effective.

In this study, researchers also conducted a survey and interviews across public and private entities, metropolitan planning organizations, city and parish governments, and planning commissions and policy departments in Louisiana. The results show that the vast majority of agencies were concerned by the safety at railroad grade crossings with only one third of them would support closing crossings to reduce their concerns. Besides safety, three other primary concerns were identified: the condition and maintenance of

crossing related facilities, traffic management, and access for active transportation (pedestrians and bicycles).

Besides NOPB Railroad, none of the state DOTD or other local agencies offer any incentive programs for at-grade crossing closure in Louisiana. Most of the respondents did not have any experience with incentive programs. When asked how they would rank provided incentive programs in terms of their effectiveness on closure of railroad grade crossings, the result shows that road improvement was ranked as the most effective, followed by nearby crossing grade separation, nearby crossing improvement, cash incentives, and track relocation.

This study comes with limitations as every research does. Due to the COVID-19 pandemic, there were different travel restrictions in place in Louisiana during the time period of this study. That limited researchers' ability to conduct in-person surveys and interviews. Particularly, researchers were unable to send out surveyors to crossings and survey daily end users in the field. In addition, researchers could not get any railroad companies to participate in either the survey or interview. Researchers did find and summarize programs and polices of crossings closure from railroad companies based on publicly available information.

Recommendations

This study aimed to investigate the impact of Louisiana's at-grade railroad crossings in order to reduce the overall number of crossings and ultimately improve the safety and efficiency of the multimodal transportation system in Louisiana. With all the findings from literature, surveys, and interviews, the following recommendations are provided for the consideration of policymaking:

1. A nationwide study found five popular incentive programs used by other states and their effectiveness ranked as (from the most effective to the least effective): track relocation, nearby crossing grade separation, nearby crossing improvement, road improvement, and cash incentives. However, professionals in Louisiana ranked them differently as: road improvement, nearby crossing grade separation, nearby crossing improvement, cash incentives, and track relocation. This study recommends that any type of incentive program would work better than no incentive program and the combination of multiple incentive programs may be more effective than any individual program.
2. Among the incentive programs, there seems to be a conflict between popularity and effectiveness due to cost of implementation. This study recommends utilizing federal funding programs and opportunities, such as cash incentives and road improvement.
3. As indicated by interviewees, good transportation polices are easily accessible, transparent, and engaging for all stakeholders throughout the whole process. Good transportation polices also need to be context-sensitive, not a one-size-fits-all policy statewide regardless of local context. The approaches that are taken in an urban area or suburban area or a rural area may be very different.
4. The importance of public education on safety and awareness is emphasized by all professionals. Impatience and carelessness when passing a crossing come from human nature, only education can reduce and change risky behaviors.
5. New technologies may provide alternatives and help improve safety and efficiency at railroad at-grade crossings, besides closure of crossings. For example, real-time train and car traffic information feedback at crossings may help improve awareness, reduce congestion, reroute, and manage traffic flow.

Acronyms, Abbreviations, and Symbols

Term	Description
ADT	Average Daily Traffic
BCA	Benefit-Cost Analysis
BNSF	BNSF Railway
Caltrans	California Department of Transportation
CN	Canadian National Railway
CPUC	California Public Utilities Commission
CRISI	Consolidated Rail Infrastructure and Safety Improvements
CSX	CSX Transportation
DOT	Department of Transportation
DOTD	Department of Transportation and Development
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FSP	Federal Signal Program
FTA	Federal Transit Administration
GCPF	Grade Crossing Protection Fund
GDOT	Georgia Department of Transportation
GNO	Greater New Orleans
HSIP	Highway Safety Improvement Program
ICRC	Illinois Central Railroad Company
INDOT	The Indiana Department of Transportation
Iowa DOT	Iowa Department of Transportation
ITS	Intelligent Transportation System
JEDCO	Jefferson Parish Economic Development Commission
KCS	Kansas City Southern
MPO	Metropolitan Planning Organization
NCDOT	North Carolina Department of Transportation
NHS	National Highway System Designation Act
NHTSA	National Highway Traffic Safety Administration
NOLA	New Orleans Louisiana
NOPB	New Orleans Public Belt
NS	Norfolk Southern Railway Company
OL	Operation Lifesaver

Term	Description
RHCP	Railway-Highway Crossing Program
RHGCP	Railroad-Highway Grade Crossing Program
RIMS	Research Information Management System
RRGCF	Railroad Grade Crossing Fund
RTA	Regional Transit Authority
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAP	State Action Plan
SGVCOG	San Gabriel Valley Council of Governments
STP	Surface Transportation Program
TWG	Technical Working Group
TxDOT	Texas Department of Transportation
UP	Union Pacific Railroad
USDOT	United States Department of Transportation

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Appendix A: Survey

Thank you for your participation in the Railroad Grade Crossing Survey! The objective of this study is to better understand the concerns, barriers, and solutions in regard to at-grade crossings of public roads with railroads in Louisiana. The goal is to reduce the number of crossings in Louisiana to improve the safety of all transportation users and the efficiency of Louisiana's Transportation System.

To participate in this study, you should have knowledge of railroad grade crossings from your professional experience as an employee of public state/local agencies or railroad companies.

This study is being conducted by UNO Transportation Institute for the Louisiana Department of Transportation and Development (DOTD) and has been approved by the University of New Orleans IRB. It will take approximately 5 minutes to complete. Your personal information will be confidential and will be not revealed in the final report.

If you have any questions about this study, please contact:
Guang Tian, Ph.D.
gtian@uno.edu
504.280.6521

1. Please provide your agency's name:

   _____

2. How much of a concern is safety at railroad grade crossings to your agency, from "1" as not at all concerned to "5" as extremely concerned?
   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

3. Other than safety, are there any other issues at railroad grade crossings concerning your agency? Please specify:

   _____

4. Do you support closure of railroad grade crossings to reduce your agency's concerns?
   A. Yes
   B. No

5. Does your agency offer or administer any incentive program (such as, cash incentives, nearby crossing grade separation, track relocation, etc.) for the closure of railroad grade crossings?
   A. Yes
   B. No

If "No" to Question 5:

6. Have you heard any of the following incentive programs to close railroad grade crossings? (Multiple responses allowed)
   A. Cash incentives
   B. Road improvement
   C. Nearby crossings grade separation
   D. Nearby crossing improvement
   E. Track relocation
   F. None

7. How would you rank these incentive programs in terms of their effectiveness on closure of railroad grade crossings, from "1" as the most effective to "5" as the least effective?
   ___ Cash incentives
   ___ Road improvement
   ___ Nearby crossings grade separation
   ___ Nearby crossing improvement
   ___ Track relocation

8. Please tell us what else do you think would be effective ways to address your agency's concerns at railroad grade crossings:

   _____

If "Yes" to Question 5:

6. Which type of incentive programs does your agency offer or administer? (Multiple responses allowed)
   A. Cash incentives

B. Road improvement
C. Nearby crossing grade separation
D. Nearby crossing improvement
E. Track relocation
F. Others, please specify _____

7. How long has the "selected option in Q6" program been in effect?
   A. Less than 1 year
   B. 1 – 3 years
   C. 4 – 6 years
   D. 7 – 9 years
   E. 10 or 10+ years

8. How would you rate the effectiveness of "selected option in Q6" program in railroad grade crossing closure, with "1" as the least effective and "5" as the most effective?
   A. 1
   B. 2
   C. 3
   D. 4
   E. 5

9. In your opinion, what are the reasons that make the "selected option in Q6" program effective or not effective?

   _____

10. Please provide any other information about the "selected option in Q6" program you would like us to know:

   _____

If you are interested in being interviewed, please provide your contact information:

Name:
Phone:
Email:

Appendix B: Participated Agencies

Agencies that have participated in the survey or interview of this research:

- Assumption Parish Police Jury
- Baton Rouge Planning Commission
- Bossier City-Parish Metropolitan Planning Commission
- Calcasieu Parish Police Jury
- Capital Region Planning Commission
- City of Alexandria
- City of Covington Planning Department
- City of Gonzales
- City of Gretna
- City of New Orleans
- Greater New Orleans, Inc.
- Imperial Calcasieu Regional Planning Commission
- Jefferson Parish Economic Development Commission
- Lafayette Consolidated Government
- Louisiana Operation Lifesaver
- New Orleans Public Belt Railroad Commission
- New Orleans Regional Planning Commission
- New Orleans Regional Transit Authority
- Parish of Caddo, Public Works
- Pineville Police Department
- Private Consultant, Planner
- Shreveport-Caddo Metropolitan Planning Commission
- South Central Planning and Development Commission
- St. Bernard Parish Government
- St. Bernard Transit
- St. James Parish
- St. Mary Parish Government
- Tangipahoa Parish Government
- Terrebonne Parish Consolidated Government
- West Baton Rouge Parish Government