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Advantages and Disadvantages of Closing Rail Crossings: A Case Study From Louisiana

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Abstract

Road-railroad crossings are where different modes of transportation meet, which brings safety concerns and the potential for hampering transportation efficiency and creating other issues. By surveying and interviewing professionals in Louisiana, this study aims to investigate incentive programs and their effectiveness in reducing the number of at-grade crossings for policy implementation. The results show that most agencies in Louisiana were concerned about safety at railroad crossings with one third supporting closing crossings to alleviate their concerns. In addition, stakeholders were also concerned about the condition and maintenance of crossings, traffic management, and access for active transportation. Among five identified programs, road improvement was ranked as the most effective program, and the combination of multiple programs may be more effective than any individual program. This study recommends that context-sensitive, accessible, and transparent policies, public education, and stakeholder engagement may help to improve safety and efficiency at road-railroad crossings overall.

Keywords

rail crossing, safety, closure, incentive program, multimodal transportation

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Introduction

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. Frequent interactions between trains and road users (automobiles, bikes, pedestrians, etc.) happen at crossings every day in the United States, which creates safety risks for the nation's multimodal transportation systems.

According to the crossing database of the Federal Railroad Administration (FRA) of the United States (OSA, 2021), there are over 430,000 crossings across the country as of 2021, of which 191,800 are closed. In 2020, there were 5503 people injured and 752 fatalities related to the railroad system across the United States, of which 688 and 197 happened at highway-rail grade crossings (BTS, 2021a). Although they have been declining nationwide in recent years, these numbers are still high and some states experience more accidents than others. In addition to present safety concerns, highway-rail grade crossings also hamper railroad operations and efficiency.

In 2010, FRA required the 10 states that had the most highway-rail grade crossing collisions to develop a State Highway-Rail Grade Crossing Action Plan to "identify specific solutions for improving" grade crossing safety and to "focus on crossings that have experienced multiple accidents or are at high risk" for accidents (FRA, 2020). These 10 states are: Alabama, California, Florida, Georgia, Illinois, Indiana, Iowa, Louisiana, Ohio, and Texas. In 2020, FRA extended this requirement to mandate the rest 40 states and the District of Columbia to develop and implement highway-rail grade crossing action plans and required the 10 states that developed plans previously to update their plans and report actions they have taken to implement them.

Most of the studies in the literature have focused on the algorithms and models predicting accidents and the effects of design features, devices, and other factors on the performance of crossings. This study contributes to the literature by adding the perspectives of professionals in practice. Using the State of Louisiana as a case, this study reviewed the incentive program policies existing in the literature that can be used to entice voluntary closure of public and private grade crossings and investigated perspectives of professionals working in this area to help improve overall safety and efficiency at grade crossings. The findings from this study are immediately useful information for policy making and practice of crossing closure not only in Louisiana but across the United States.

Background Information

Federal Guidelines

There are two practical guidelines directly related to railroad crossings from the federal government of United States: *Highway-Rail Crossing Handbook* and *Highway-Railway Grade Crossing Action Plan and Project Prioritization*. In the

Highway-Rail Crossing Handbook (Ogden & Cooper, 2019), closure is recommended as the first alternative for a highway-rail crossing since it provides the highest level of safety, reduces traffic delays on road and rail, and lowers maintenance costs. However, it may not always be fully beneficial or practical due to other factors, such as community resistance, funding, legal challenges, etc. The closure of crossings should give high priority to redundant, geographically close, or unnecessary crossings. The selection of crossings for closure should be a balance among safety, traffic flow, accessibility of communities, and cost-benefit efficiency. In addition, the handbook recommends other measures, including grade separation, relocation, site improvements, etc.

In the *Highway-Railway Grade Crossing Action Plan and Project Prioritization* (Rutter et al., 2016), states are required to identify "specific solutions for improving safety at crossings, including highway-railway grade crossing closures or grade separations" (Page 1). By using a cost and benefit analysis, the action plan provides an evaluation of nine crossing improvements. Both crossing closure and grade separation are 100% effective in terms of the expected reduction in the number of highway-railway collisions. The estimated cost of closure ($25,000 to $100,000) is much lower than grade separation ($5 million to $40 million).

Funding Sources

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. Currently, there are three federal funding sources for crossing safety improvements: Section 130 set-aside funds; federal-aid highway funds, such as National Highway System Designation Act (NHS), or Surface Transportation Program; and safety program funds, such as Highway Safety Improvement Program (Ogden & Cooper, 2019).

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.

Railway-Highway Crossing (Section 130) Program (FWHA, 2021), launched in 1987, is a form of cash incentive program offered by the federal government to local communities that are under the impact of closing rail-road crossings. Crossing consolidations, elimination, and re-location are among eligible activities or the use of Section 130 safety funds. Between 1987 and 2014, the Section 130 program has been significantly associated with decreased fatality at rail-road crossings. Among 22 states that offer incentive programs in Codjoe's study (Codjoe, 2018), 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 $7500 for each crossing. 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 to continue funding at the current level. It was also recommended to increase the closure incentive

Table 1. Incentive Programs (Codjoe, 2018).

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 $7500	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.

cap from $7500 to $10,000 and incentivize states to pack various crossing projects into a single grant application (Sneider, 2020).

An Earlier Study

In addition, Codjoe (2018) conducted a nationwide survey on crossing closure policies from state departments of transportation (DOTs) and railroad agencies in the United State. In the study, five types of incentive programs were recognized for road-railroad crossing closures. Table 1 summarizes the description, popularity, and effectiveness of these programs. Popularity is measured by the number of states that reported offering the incentive program in the survey. Effectiveness is measured on a Likert scale of 1 (least effective) to 5 (most effective) that respondents rated the effectiveness of each incentive program in the survey.

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

types of incentive programs (except track relocation) generated 40.8% of crossing closures.

Other Studies

In the literature, studies have been conducted with a focus on different aspects of highway-rail grade crossings to improve safety and efficiency. There are a few studies aimed at predicting crashes and identifying potential hazardous crossings for treatments. Djordjević et al. (2018) developed a modified non-radial DEA (Data Envelopment Analysis) model to evaluate safety at crossings and plan updating particular crossings in European countries. Pasha et al. (2020) developed a new hazard prediction model, called Florida Priority Index Formula, to assess potential hazards of a given crossing and prioritize crossings for upgrades in Florida. Using 19-year crossing data in North Dakota, Gao et al. (2021) proposed a deep learning-based approach to predict collisions at crossings. With resampling the imbalanced dataset and other improvements, they found that this new approach had better predicted performance compared to other machine learning-based methods. Zhou et al. (2020) assessed crash prediction accuracy at crossings using a random forest algorithm and decision tree. They found that the random forest method dramatically improved the prediction accuracy without providing additional false negative predictions or false alarms.

Another group of studies tried to examine the effects of different devices and design features on safety and traffic. Landry et al. (2019) examined the effect of a warning device, called in-vehicle auditory alerts (IVAAs), on drivers' behavior of compliance. Through two experiments, they found that with the combination of visual warnings, IVAA was very effective at informing and reminding drivers of how to comply at crossings. There was even a lasting effect on drivers' behavior after the IVAA was no longer presented. Zhang et al. (2018) presented a Computer Vision (CV) algorithm to automatically detect trespassing near misses based on surveillance video footage at crossings. This CV methodology could be used for data-driven grade-crossing near-miss risk analysis and proactive safety improvements at grade crossings. By investigating 3194 public crossings in North Dakota, Keramati et al. (2020) evaluated the effects of four geometric features (acute crossing angle, number of tracks, roadway distance, and number of highway lanes) of crossings on crash occurrence and severity likelihoods. They found that the four geometric features significantly affected at least one crash severity level and crossings with three main tracks contributed the most to long-term crash probabilities. Singh et al. (2021) reviewed 578 crossings in Florida that experienced at least one collision from 2010 to 2019 and investigated various factors to understand the major causes behind crashes. They found that the majority of crashes occurred at public crossings that have either two-quad or four-quad gates, many of which were not illuminated, or urban crossings with high traffic volumes of high-speed traveling trains and vehicles. Pasha et al. (2021) proposed a new approach to estimate the overall traffic delay at crossings with the existing warning devices and assist with the selection of countermeasures for crossing upgrades by estimating traffic delays

before and after implementation of countermeasures. Soleimani et al. (2021) developed a consolidation model (using Text Mining Techniques, Geospatial Analysis, and XGboost Machine Learning algorithm) to help close redundant crossings and thereby decrease crash risks. Using a simplified model utilizing 14 variables, they found that 15% of current crossings should be closed.

The management of crossings usually faces a balance between safety and efficiency with limited budgets. Kavoosi et al. (2020) developed two optimization models for resource allocation among highway-rail grade crossings to minimize the overall hazard and the overall hazard severity, taking into account the available budget limitations. Singh et al. (2022) and Pasha et al. (2022) presented a framework for multi-objective resource allocation to minimize the number of crashes and the total delay at level crossings. Using case studies in Florida, they demonstrated superiority of the exact optimization method and provided insights for railway authorities and other stakeholders involved in crossing safety improvements.

A recent literature review about the safety and performance of highway-rail grade crossings was conducted by Vivek et al. (2021). They identified seven critical research gaps in the current literature including the effect of highways' operational characteristics on the performance of crossings, the dilemma of drivers, and the proactive safety evaluation of pedestrians and non-motorized vehicles at crossings.

Methodology

A Case Study of Louisiana

The State of Louisiana is where the Mississippi River empties into the Gulf of Mexico. It has a multimodal transportation system of highways, rail, transit, ports, airports that connects land, water, and air for freight and passengers. It has 16,660 centerline miles of highways, which is the 11th largest highway system in the United States (DOTD, 2015). It has 2583 main track miles of six Class I railroads, which are connected by the New Orleans Public Belt Railroad Commission and serve the only seaport–the Port of New Orleans–in the United States that is connected to six Class I railroads. It has three of the top 10 United States water ports in terms of tonnage in 2020: Port of South Louisiana (second, 225 million tons), Port of New Orleans (fifth, 81 million tons), and Port of Baton Rouge (seventh, 72 million tons) (BTS, 2021b). When these highways and railroads meet, it creates crossings.

Figure 1 shows the distribution of different types of crossings in Louisiana. As of 2021, there are 9077 crossings in the State of Louisiana (RIMS, 2021). Of which, 5534 crossings are currently active, and 3543 are inactive or closed. Among the active crossings, there are 3173 public crossings, 2353 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, according to 2020 Census data, Louisiana has a population of 4.66 million. 45.7% of this population lives within one mile of an active at-grade crossing. 74.1% of

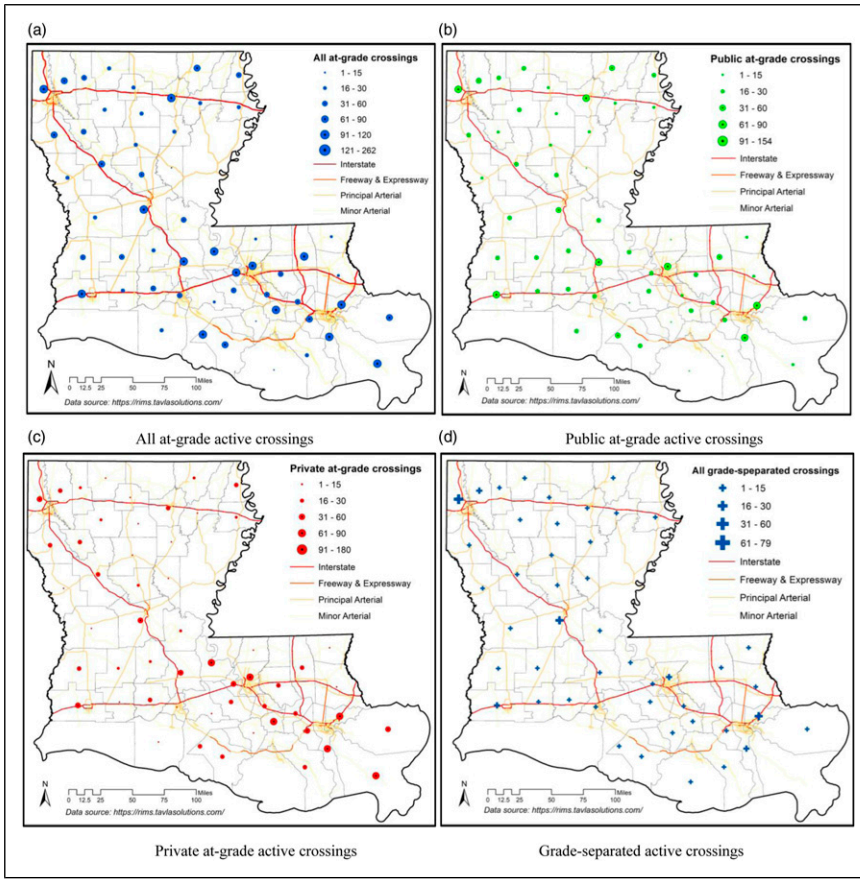

Figure 1. The distribution of different types of crossings in Louisiana.

this population lives within three miles of an active at-grade crossing. The daily interactions among different transportation modes create a great case study of crossing policies.

Survey Design

The main themes of the survey were safety and other concerns related to crossings and existing programs as well as the effectiveness of crossing closures at mitigating those concerns. The survey questions were designed based on findings from the literature review. The main questions in the survey included:

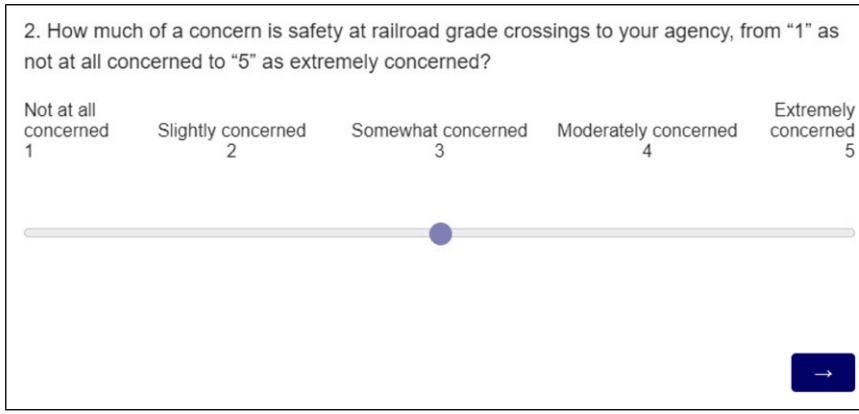

Figure 2. An example question from survey.

- 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.

Figure 2 shows a screenshot of the final appearance of one question in the survey. See Supplemental Appendix the full list of questions used in the survey. The survey was designed and administrated by using the Qualtrics platform, which is an online survey tool that is widely used in research.

Survey Distribution and Interview Conduction

The survey was intended for people who have knowledge of railroad grade crossings from their professional experience as employees of public state or local agencies or railroad companies. The process started with websites of cities, parishes, and state agencies to develop a contact list of transportation professionals and planners across Louisiana. Due to the constraint of time and resources, 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, the contact information of 344 personnel from 145 agencies were collected, including eight Metropolitan Planning Organizations (MPOs), 56 cities, 49 parishes, and 32 related professional agencies. Between July 21 and August 24, 2021, 344 stakeholders were contacted via email and invited 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. 221 emails were 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.

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, 2021. Due to Hurricane Ida, some of the interviews were rescheduled to late September.

Final Sample

At the end, there were 39 meaningful survey responses (with answers to the main questions) out of 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. Although this study was unable to get any personnel from railroad companies to participate, railroad companies' policies related to rail crossings were found from online sources and previous studies, which were discussed in the following section. Figure 3 shows the distribution of survey responses. While not every parish or city that has crossings within their jurisdictions responded, the participating agencies were distributed across the state. Particularly, there were more participants in the south and southeast parts of the state, where both grade crossings and population were more concentrated.

Discussion of Results

Findings from the Survey

Safety. For the first question regarding to safety at crossings in Figure 4, 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 concern to their agencies at all. Overall, safety at crossings is a concern to the majority of respondents.

Other concerns. When asked what other issues at railroad crossings were concerning their agencies in addition to safety, respondents provided wide range of answers. These answers were summarized into the following categories with frequencies they were mentioned in Table 2.

Besides safety, the three primary concerns were the condition and maintenance of crossing related facilities, traffic management, and access for active transportation. Specifically, respondents expressed their concerns about the poor condition of crossing surfaces 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

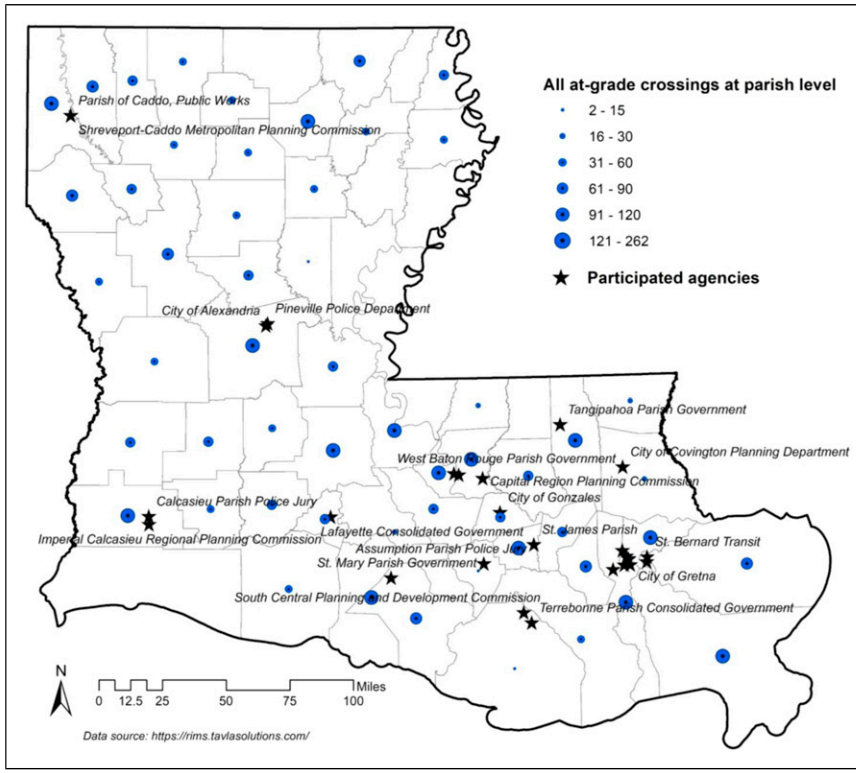

Figure 3. Agencies who participated in this study.

the traffic management at crossings by citing traffic congestion, traffic flow interruption, high volume of trains, etc. The next major concern was the 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 difficult 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 way.

Closure support. The previous questions show there are safety and other concerns related to crossings. However, only about one third of respondents (12 out of 35) supported closing crossings as the means to alleviate 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."

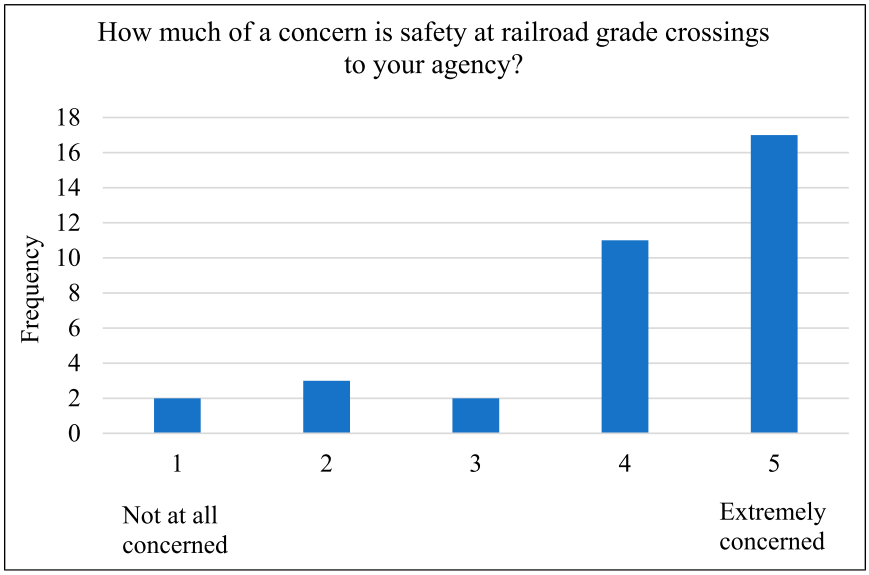

Figure 4. Safety concern.

Table 2. Other Concerns.

Concerns	Description	Frequency
Condition	the condition and maintenance of crossing surface and equipment	11
Traffic management	the efficiency of moving traffic, traffic congestion, traffic flow interruption	10
Active transportation	access for pedestrians and cyclists (such as sidewalk, bridge, etc.)	6
Access	access for public utilities and permission of railroad right-of-way for public projects	2
Community	community connectivity and revitalization	2
Emergency response	emergency response	1

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 improve traffic flow and saved the railroad companies money in equipment and labor, and they were the safest ways as well.

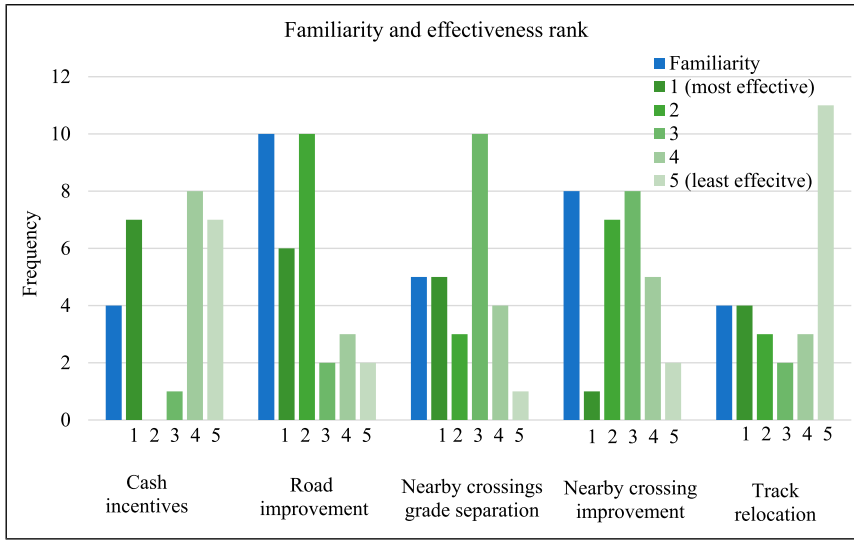

Figure 5. Familiarity and effectiveness rank of incentive programs.

The description of the incentive programs is shown in Table 1. Nineteen out of the 33 respondents have not heard of 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, as shown in Figure 5. 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 perceived 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" the least effective program. The ranking of all five programs is:

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

It is worth noting that "road improvement" is the most familiar program to the respondents and was 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.

Respondents were also asked to provide any other effective ways to address their agencies' concerns at railroad at-grade crossings. The answers are 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 the day;
- Increasing railroad responsiveness and cooperation in maintenance efforts; and
- Federally funded grade separation efforts.

Findings from the Interview

Analyzing the content of the interviews, several major themes were emerged. including regulation, technology, policy, public engagement, and funding. In the following, the perspectives of interviewees on those subjects are summarized. Regarding the closure of grade crossings, three different perspectives emerged.

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, Louisiana Department of Transportation and Development (DOTD) and Regional Transit Authority (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 neighborhoods off from one to another, and that is one reason that local communities hesitate to close some existing crossings. Local communities can be impediments to crossing closure projects because such projects may limit their mobility or decrease their social cohesion, especially if there is a coherent sense of being a single neighborhood on both sides of a track. A good transportation policy also has to be context-sensitive, not a 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 the strongest potential 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. Operation Lifesaver (OL, a non-profit organization focused on rail safety education) 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 conflicting perspectives on the closure of at-grade crossings depending on their immediate or long-term benefits. On the one hand, freight railroad companies want safer, faster, and more frequent operations and, therefore, are supportive of closing as many crossings as possible. On the other hand, residents are not receptive to heavy railroads and the noise of train horns to their community. They do not want to be burdened with the extra travel distance to bypass around a closed crossing. The interviewees brought up three different viewpoints based upon their specialties and concerns. Some interviewees fully supported closing redundant crossings as long as it makes the environment safer for the public. In contrast, some other interviewees did not suggest closing a crossing as the first alternative. Instead, the interviewee suggested that all other scenarios should be thoroughly explored, and it is necessary to consider every other alternative way to achieve a safety goal before closing a crossing. Some other interviewees were not directly involved with railroad safety crossing issues, thus they did not provide any explicit comment on the question of 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 them.

Conclusions

This study investigated existing incentive programs in the literature and perspectives of professionals working in this area in Louisiana to help reduce the number of crossings. The findings from this study are useful for policy makers that aim to reduce the overall number of crossings and ultimately improve the safety and efficiency of a multimodal transportation system.

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

implementation. 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 crossing closures. It concluded that the combination of multiple incentive programs would be more effective.

In this study, we 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 are concerned about safety at railroad grade crossings, but only one third of them would support closing crossings to mitigate 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).

With the exception of NOPB Railroad, none of the state DOTD stakeholders 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 perceived 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 effort 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 the researcher's ability to conduct in-person surveys and interviews. Particularly, the researcher was unable to send out surveyors to crossings to survey daily end users in the field. In addition, the researcher could not get any railroad companies to participate in either the survey or interview. The researcher did find and summarize programs and polices pertaining to crossing closures from railroad companies based on publicly available information. This study calls for future research focused on getting more stakeholders engaged, such as daily crossing users, surrounding communities, private crossing owners, etc., to better understand their opinions in order to improve efficiency and safety at grade crossings. Also, it would be valuable to conduct a pilot study on certain programs to observe and compare changes in people's attitudes and behaviors before and after the implemented program.

Policy Recommendations

Based on the findings from literature, surveys and interviews, the following recommendations are provided for the consideration of policymakers:

- 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.

- 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.
- As indicated by interviewees, good transportation policies are easily accessible, transparent, and engage all stakeholders throughout the whole process. Good transportation policies 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 versus a suburban area or a rural area may be very different.
- 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.
- 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, facilitate rerouting, and manage traffic flow.

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Supplemental Material

Supplemental material for this article is available online.

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