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Cost Analysis of Railroad Grade Crossing Projects Performed by Railroad Organizations in New York State.

Keywords:
railroad grade crossings, cost overruns, railroad organizations, risk. Total project costs, total project costs

PEER -REFEREED APPLIED RESEARCH

Cost Analysis of Railroad Grade Crossing Projects Performed by Railroad Organizations in New York State.

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Abstract

Total project cost is usually finalized at the completion of the project. This cost often includes overruns that are approved and in most cases peculiar to the project. This study analyzed the total costs of public railroad crossing projects that were federally aided and performed by different type/class of railroad organizations in New York State, including passenger and freight railroad organizations. Cost data on 256 public highway rail intersection (HRI) projects performed between 2002 and 2012 were gathered and analyzed while the posited hypothesis was tested with non-parametric test using SPSS Statistical package, version 20. The Kruskall Wallis test was used to determine the statistically significant difference between the total cost of projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies operating in New York State. Post-hoc test depicts the significant differences between the railroad organizations concerning the total cost of completing similar projects. Findings indicated that there were statistically significant differences in total costs of projects based on the contracting methods used and the types/class of railroad organizations performing the projects (p=0.004). Based on the study findings, it was recommended that the New York State Department of Transportation partner with the railroad organizations towards share cost agreement, develop short or long-term plans to either close railroad grade crossings or grade separate crossings along railroad corridors so that passenger and Class 1 railroad organizations can significantly contribute to HRI improvements. Furthermore, the government inspectors should adequately monitor the federal aided HRI projects performed by the railroad organizations.

Introduction

The primary objective of any project owner is to ensure that the project is completed within the specific budget and on time. Lawal and Onohaebi (2010) maintained that regardless of the size and complexity of a project, it must be goal oriented. To achieve the project goal, it is important to identify the problems that a proposed project is meant to solve. However, at the completion of every project, a final account is performed to indicate the total costs relative to project input and management. The project cost can be described as a part of important issues in a project success. Based on its importance, most construction projects failed to achieve their objectives within the specified cost (Durdyev, Ismail & Abu Bakar, 2012). As a result, situation arises when costs exceed the contract amount because of reasons that are excusable or not excusable. Avotos (1983) indicated that cost overruns occur when the final cost of the project exceeds the initial estimate or budget. Brechman and Wu (2006) defined cost overruns as the excess of actual project costs over budgeted costs. The total cost of a completed project includes applicable overruns that have been paid for. It may be caused by underestimation of costs at the planning stages or by the escalation of costs during implementation due to unforeseen events, changes in the scope of the project, change order, design error or poor management. These can affect the overall financial goal of a project owner when it exceeds the defined budget. As cost overruns leads to excessive amount expended on construction projects, Ioannou and Liu (1993) expressed that excessive construction costs have eroded the construction industry's competitive position. Shortness of funds can result into project abandonment as well as project delay.

As part of infrastructures along the rail corridor, highway-rail intersections (HRI) are located at different points where the railroad intersects the highway (roadway). HRI is an infrastructure that impacts land transportation systems, which consist of road and rail, and the traveling public that use the systems. In countries like Australia, the UK and Nigeria, HRI is called a Level Crossing. In this study, the term highway-rail intersection was used interchangeably with the term railroad grade crossing. Bowman, Stinson and Colson (1998), stated that highway-rail intersections involve two completely different modes of transportation with different operating authorities and operation characteristics. In the United States, different railroad companies own the right-of-way along their respective corridors where the track bisects the highway. Most of the railroad crossings have been created over the years, but they require continuing improvements, which have been exacerbated by costs of improvements.

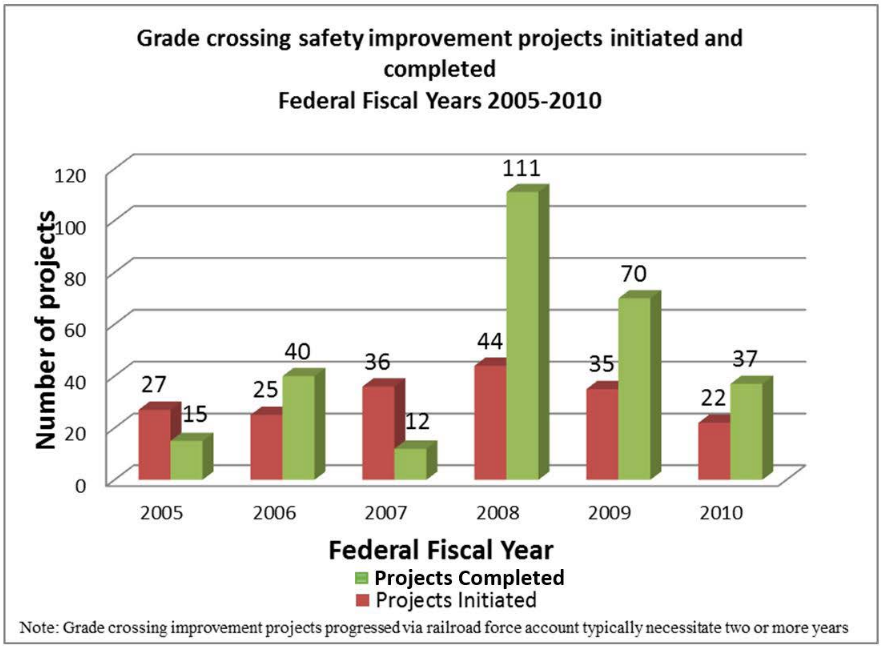
Transportation agencies are experiencing unprecedented pressure to deliver projects. No single factor has created this situation; many independent influences have contributed to this high demand environment (NCHRP Project 20-68A, Scan 07-01). Highway – Rail Intersection projects are necessary to avoid fatalities and injuries to users of the systems. The Federal Highway Administration (FHWA) through Section 130 of Code of Federal Regulations (CFR) 23, funds public highway-rail intersection projects which are matched by states in the United States of America for improving HRI's

This study assessed the cost implications of the highway-rail intersections projects with the same scope. The projects selected for this study are primarily those that were fully upgraded with Flashing lights and Gates in New York State.

Background

The railroad crossings are located at freight and passenger rail corridors. Projects are initiated by the states in conjunction with railroad companies that owned the tracks and/or operate on the tracks at these crossings. There was no targeted cost or specific methods for delivering all highway-rail intersection projects other than project performance by railroad organizations, which is based on respective capabilities. Based on the size of railroad organization, it uses its own in-house workers for Design-Build or use the Design-Bid-Build (conventional) method for project implementation. The bottom line is that in recent time NYSDOT has been experiencing funding constraints to implement candidate HRI projects and as well experience increasing total project cost. The funds received from the Federal Highway Administration in the past 10 years have been in the average of six million dollars. However, according to the NYSDOT (2013), HRI improvement projects that were initiated and completed between fiscal year 2005-2010, declined from year 2008 to 2010. The peak recorded in 2008 was because various project improvements performed in downstate New York were closed. The following chart depicts the HRI projects that were initiated and completed in New York State from 2005 to 2010:

Figure 1. Grade crossing safety improvement projects initiated and completed in Federal Fiscal years 2005-2010. Sourced from the New York State Department of Transportation



Research Question

This study focused on one major research question as described below:

Is there any statistically significant difference between the total cost of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies from 2002 to 2012?

Literature Review

The railroad grade crossings located at freight railroad corridors hinder mobility to freight and passenger trains. In certain corridors, both passenger and freight trains share the rail lines. These lines are bisected by roadway and expose motorized vehicles and pedestrians to the trains, which can affect mobility and cause incidents. According to Todd (2011), mobility refers to the movement of people or goods. It also assumed the travel of persons or ton miles, and determined trips as person or freight vehicle trip. The Indiana State Department of Transportation (2014) indicated that mobility depends on seamless integration of transportation infrastructure. Hence, for mobility and safety at the railroad grade crossings, there is the need for project improvements which include installation of warning devices, surface work and circuitry upgrades by railroad organizations.

In the course of implementing these projects in New York State, project final costs do increase from what was approved and awarded. Project cost overruns and rising cost have been of great concerns in the construction industry. Ioannou and Liu (1993) argued that excessive construction costs have eroded the construction industry's competitive position, while many projects have been abandoned and delayed because of shortness of funds. Ismail, Aftab and Ahmad (2012) expressed that the completion of any project within the estimated cost is the basic criteria for the success of a construction project. The primary target of practitioners involve in construction projects is to complete the project within budgeted cost regardless of size and complexity of the project. He further stated that completion of any project highly depends on the construction resources. The resources available for highway-rail projects in New York have been used towards insuring successful completion of the projects until recently that the resources appear not enough to accomplish desired projects, which are expected to be of good quality and meet its goal of completion as well as safety to users of the system. Pinter and Psunder (2011) explained that project success in the past was usually measured in terms of total costs and time required for the project completion, but now, it stands to successfully achieve its goals relative to cost, time, quality and other given criteria.

In the course of improving HRI's, the total project costs of HRI deviated from the original estimate as a result of cost overruns. Avotos (1983) indicated that cost overruns occur when the final cost of the project exceeds the initial estimate or budget. Ali and Kamaruzzaman (2010) indicated that cost overrun is a very common phenomenon and majority projects in construction industry faces this problem. Likewise, Baloi and Price (2013) stated that cost overrun is regarded as normal occurrence in the construction industry

According to Edward (2009), cost overruns have plagued governments for decades. Projects that are funded by the federal government and carried out by the state governments appeared to be mismanaged because of little incentive for managing the funds wisely, bearing in mind that these projects are footed by federal taxpayers. In essence, because of the cost overrun, the federal government can challenge the State governments, while the State governments can challenge the contractors or the railroad organizations using these funds. The commonality among State Departments of Transportation is the inability to complete projects on time and within budget (Bordat, McCullouch, Labi & Sinha, 2004). Regarding railroad grade crossing projects, highway trust funds are used and contractual agreements are developed and entered between NYSDOT and Freight railroad organizations. The estimates submitted by the railroad organizations forms the basis for the contract amount. HRI projects are executed at locations in need of improvements in New York State, irrespective of project scope and final cost. Any variability from the original project contract amount could be based on various reasons and could be different from one project to another.

Delays in project implementation and the attendant cost overruns are regular feature of public sector projects. When projects get delayed and build up overruns, the government is required to approve revised estimates (Morris, 1990). The railroad organizations in New York State submits revised estimate to the New York State Department of Transportation after passage of time of earlier submissions prior to approval of plan specification and estimate packages. In certain instances, approvals were sought for claims after project implementation.

Bordat, McCullouch, Labi and Sinha (2004) in their analysis of Indiana State Department of Transportation projects, expressed that increase in total cost in construction contracts involve change orders and claims. They asserted that cost overruns, time delays and change orders are generally due to factors such as design errors, unexpected site conditions, increases in project scope, weather conditions and any other project changes. When there is poor scope definition, final project costs can be expected to be higher because of the inevitable changes which disrupt project rhythm, cause rework, increase project time, and lower the productivity and morale of the work force (Construction Industry Institute, 2003). The Federal Railroad Report of 1986 on "Northeast Corridor" expressed that preparation of the project scope must be thorough and complete before final funds are committed because once the final scope has been established and timetables set, any changes will usually bring increased costs and delay the project. Furthermore, Mokbel (2003) indicated that a change order is an action that specifies and justifies a change to the scope of a construction contract, which alters the original time of completion or the project total cost, or both. A change in scope, design errors etc, could lead to project delay and as well affect total project costs.

Flyvbjerg, Holm and Buhl (2004).) tested what caused construction cost escalation in transportation infrastructure projects in Europe. He focused on the length of the implementation phase, the size of the project and type of ownership. The cost escalation was found to be highly dependent on the length of project implementation, which did not vary between rail, bridge and tunnel and road projects. He recommended that decision makers need to be concerned about long implementation of large projects. HRI projects are not large projects but still encounter increase in original project cost.

Since railroad grade crossing projects do involve equipment upgrade and use of technology, which has transformed operation and construction practices, lack of knowledge of the technology could constitute a risk. Hence, poor risk management practices can affect the project cost and performance. Leavitt, Ennis and McGovern (1993) explained that much of the new technology proved problematic with major delays and design changes. They further argued that cost did escalate significantly as a result of inflation and design changes. Railroad grade crossing projects comprise upgrade of circuitry systems into predictors from different manufacturers, changes incandescent lights to Light Emitted Diode lights, etc.

Lundberg, Jenpantsub and Pyddoke (2011) expressed that despite all emphases been put on improving cost calculation. They suggested that risk based estimates which should be based on principal components analysis should be developed. This method use data from a developed database, which must be monitored and updated.

Since most project costs are affected by one reason or the other, control of cost is very essential to reduce the magnitude and the effect of costs on the overall aim of a project. Azhar, Farooqui and Ahmed (2008) noted that cost is among the major considerations throughout the project management life cycle and can be regarded as one of the most important parameters of a project and the driving force of project success. Li (2009) asserted that implementation stage of a construction project is a stage that requires the most resources in the process of project construction and it requires control to avoid economic loss. Therefore, in order to minimize the norm of increasing total project costs, Gould (2002) indicated that efficient management is important to produce a productive and efficient site, which can be applicable to railroad project crossing locations.

Methodology

This study was conducted to assess the distribution of total project costs for railroad grade crossing projects performed by different type/class of railroad organizations in New York State. The authors used a total population sampling to select the projects. The sampling method was a type of purposive sampling technique that involves examining the entire population (i.e., the total population) that has a particular set of characteristics (Laerd

Dissertation, 2012). For this study, 256 public HRI projects were selected based on available data among 368 closed projects. The selected projects consist of similar scope and were completed between 2002 and 2012. These projects were independent (specifically for each HRI project location) and were not repeated. They were designed, constructed and completed. The selected HRI projects were Federally Aided and administered by the New York State Department of Transportation. They are public railroad grade crossings, which were contracted between the New York State (NYS) government and Railroad organizations operating within New York State during the aforementioned period. These projects were representative of all types/class of railroads. Data were sourced from the New York State Department of Transportation (NYSDOT). The retrieved data types were continuous and categorical, measured in ratio and nominal scales respectively based on the variables. The applicable variable with continuous data for this study is Total Project Cost (TPC), while variable with categorical data is the Railroad Organization Class (ROC). The railroad organizations were classified into Class 1, Class II, Class III and Passenger. The project scope, which consists of Installation of Flashers and Gates, is the same for all selected projects. For analysis purposes, the categorical data were coded numerically.

The retrieved data were copied from the project database into a Microsoft Excel spread sheet. They were sorted, arranged, checked for errors to ensure accuracy and screened for validity. The data in the spreadsheet were imported into a SPSS 20 statistical package in order to provide a description and inferences of the targeted population from which the data were collected. The data were screened for normality. The test for normality was performed using the Shapiro-Wilk test. The data failed normality test.

The data were analyzed using descriptive and inferential statistical analysis. The independent variable is the Class of Railroads with four different levels. The dependent variable in the hypotheses that needed to be tested was Total project cost (TPC) of highway-rail intersection projects. Each value of the dependent variable is continuous, while that of the independent variable is categorical. Shapiro-Wilk test was used as a numerical method to determine if the data were from a normally distributed population. Because the original data failed a parametric assumption, a non-parametric test, which is Kruskal-Wallis test was considered. It allows the comparison of two or more independent groups (Laerd statistics, 2014)

The non-parametric test does not require satisfaction of normality assumption. As indicated by Laerd Statistics (2014), the dependent variable must be continuous or at least have ordinal data, while the independent variable must consist of two or more categorical, independent groups. The Kruskal-Wallis test was used to test the following hypothesis to address the research question:

- H0: There is no statistically significant difference between the total costs of HRI projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies
- H1: There is a statistically significant difference between the total costs of projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies

The Kruskal-Wallis test was automatically chosen by SPSS 20 because the levels of the Class of Railroads were four. It ranked the original data and indicated the Chi-Square. The median was also reported.

Findings

TThe descriptive statistical analysis in Statistical Package for the Social Sciences (SPSS) Version 20 was used to analyze the data after importing them from a Microsoft Excel file.

Table 1 below indicated that approximately, 55% of the projects from 2001 to 2012 were performed by Class 1 railroad organizations, 23% of the projects were performed by Class 3 railroad organizations, 12% of the projects were performed by Class 2 railroad organizations and 10% of the projects were performed by Passenger railroad organizations.

Table 1. Projects performed by different Types/Class of Railroad Organizations in New York State from 2002 to 2012

ROC	Frequency	%
Class 1	140	54.69
Class 2	31	12.1
Class 3	59	23.05
Passenger	26	10.16

Note: N = 256

The Shapiro-Wilk test was used as a numerical test to determine if the data were from a normally distributed population to determine an underlying assumption for using a parametric test. Based on a significance level of 0.05. Table 2 indicates that Class 1, Class 2 and Class 3 respectively have a sig value of 0.00 while Passenger had a significance value of 0.012. They are all significant at $p< 0.05$

Table 2. Shapiro-Wilk Test of Normality for TPC on ROC

ROC		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Class 1	TPC	.204	140	.000	.697	140	.000
Class 2	TPC	.223	31	.000	.758	31	.000
Class 3	TPC	.195	59	.000	.824	59	.000
Passenger	TPC	.190	26	.017	.895	26	.012

a. Lilliefors Significance Correction

It is evident from the sig values in Table 1 that the data tested deviated from a normally distributed population, because they were less than 0.05. Using a parametric test will not give a valid result. Hence for failing the normality assumption, a non-parametric test was considered.

In response to the research question which states that, Is there any statistically significant difference between the total cost of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies? A Kruskal-Wallis H test, which is a non-parametric test was run to determine if there were significant differences between the total cost of HRI projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies. The analysis was conducted on data for 256 selected HRI projects and the non-parametric test in SPSS 20 was performed on class of railroad organizations with four independent levels, Class 1, Class 2, Class 3 and Passenger. Table 3 displayed hypothesis-test summary using Kruskal-Wallis test. It displayed asymptotic significant value of 0.00 which is less than 0.05. The asymptotic significance is a p-value calculated using an approximation to the true distribution. Similarly, Figure 2 (model viewer), which indicated the independent samples test showed the same result, with asymptotic significant value of 0.00. The test was statistically significant at $p<0.05$. Because the sig value 0.00 is less than the 0.05 significant level, we reject the null hypothesis and considered the alternative hypothesis. In essence, the total cost of HRI projects was statistically significantly different between Class 1, Class 2, Class 3 and Passenger railroad organizations, X2 (3) = 23.461, p = 0.000 based on the p value (0.00<0.05). Since there are four different classes of railroad organization, there was at least a difference in the total cost of performing HRI projects among the class of railroad organizations. The distribution of the total project cost was not the same between the total cost of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies.

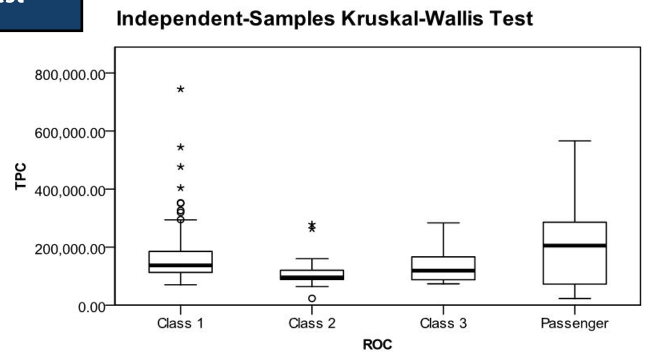
In order to determine which class of railroad organizations differs between each other in terms of total cost on projects performed, a post-hoc analysis was conducted. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. The post-hoc analysis shown in Figure 3 indicated that total cost was statistically significantly different between Class 2 (Mdn = 95,829.00) and Passenger (Median =205,246.50) (p = 0.010), Class 2 (Median = 95,829.00) and Class 1 (Median = 137,108.08) (p = 0.000) and Class 3 (Median = 118,945.00) and Class 1 (Median = 137,108.09) (p = 0.033). The medians for the different levels of class of railroad organizations were reported in Table 4. The asymptotic significance values aforesaid, which were less than 0.05 significant level, indicated significant differences. The costs of the projects performed between the aforesaid railroad organizations were not the same. The median project cost performed by each railroad differed. It is an indication that the New York State Government have obligated more funds to the railroad organization with higher project costs. This could impact the total number of project that need to be implemented by different railroad organizations statewide. Similarly, the tax payers from various localities where rail crossing improvements are needed may not be benefiting equitably.

Table 3. Kruskal-Wallis Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of PC is the same across categories of ROC	Independent-samples Kruskal-Wallis Test	000	Reject the null hypothesis

Asymptotic significances are displayed. The significance level is .05

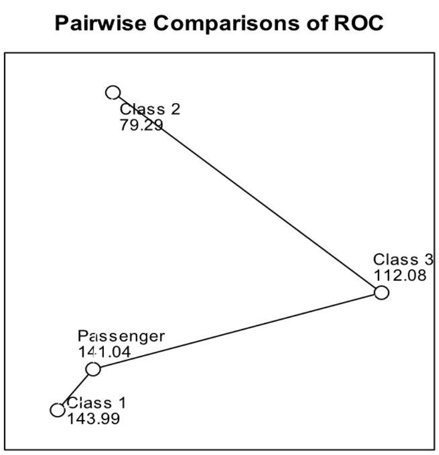
Figure 2. Model Viewer for Kruskal-Wallis Test



Total N	256
Test Statistic	23.461
Degrees of Freedom	3
Asymptotic Sig. (2-sided test)	.000

1. The test statistic is adjusted for ties.

Figure 3. Show Pairwise Comparisons of the mean rank of TPC for levels of ROC



Each node shows the sample average rank of ROC.

Sample1-Sample2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Adj.Sig.
Class 2-Class 3	-32.794	16.425	-1.997	.046	.275
Class 2-Passenger	-61.748	19.691	-3.136	.002	.010
Class 2-Class 1	64.695	14.698	4.402	.000	.000
Class 3-Passenger	-28.954	17.430	-1.661	.097	.580
Class 3-Class 1	31.901	11.493	2.776	.006	.033
Passenger-Class 1	2.947	15.812	.186	.852	1.000

Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.
Asymptotic significances (2-sided tests) are displayed. The significance level is .05.

Table 4. Median Report for Class of Railroad Organizations

ROC	TPC ($)
Class 1	137,108.09
Class 2	95,829.00
Class 3	118,945.00
Passenger	205,246.50
Total	129,898.99

5.0. Summary, Discussions, and Conclusions

This study was conducted to assess the distribution of total project costs of projects federally-aided to improve public railroad crossing by passenger and freight railroad organizations in New York State. The railroad organizations involved in Highway-rail intersection projects implementation are both the Freight and Passenger railroad organizations. The Freight railroad organizations are classified into Class 1, Class 2, and Class 3, based on operational revenue, while the Passenger railroad organization are those that carry passengers either for intracity, inter-city or tourist purposes. As expressed by the Association of American Railroads (2013), Class 1 railroad is a railroad with operating revenues of at least $432.2 million; Class II is Regional railroad known as line-haul railroad that has annual revenues of at least $40 million or operates at least 350 miles of road, while Class III is local railroad, which engage primarily in line haul service including Switching/terminal services for other railroad organizations. The Class III railroad are also known as Short line railroads. Generally, Class III carriers are referred to as short lines and Class II are referred to as regional railroads (American Short line and Regional Railroad Association, n.d).

The findings indicated that there is a significant difference between the total costs of Highway-Rail Intersection projects performed by the railroad organizations. The post-hoc analysis shows those costs that were significantly different from each other. The total costs of projects performed by Class 1 railroad organizations were different from those performed by Class 2 and Class 3 railroad organizations. Class 1, 2 and 3 railroad organizations are freight railroad organizations. The Class 1 railroad organization is the largest of the freight railroad organizations. The difference in cost of projects performed by Class 1 was likely due to higher administrative and overhead costs charged by the concerned railroad organizations when compared to Class 2 and 3 railroads. In addition, the NYSDOT claimed that the Class 1 railroad organizations do have higher cost overruns when compared to other types of railroads. In most cases, the Class 1 railroad organizations use their in-house workers and assumed higher risks, which can contribute to the significant difference in the total costs of projects they performed when compared to Class 2 and 3 railroad organizations.

Findings also show significant differences between the total cost of HRI projects performed by Passenger railroad organizations and Class 2 railroad organizations. The passenger railroad organizations are commuter and tourist railroad organizations, which are mostly located in downstate New York. Both types of railroad organizations mostly used their in-house workers, but the difference in the total project cost would likely be the difference in the type of circuitry used for warning devices at their respective crossings. In addition, the administrative and overhead costs charged on the projects are likely different. There was no statistical significant difference between the total costs of HRI projects performed by Class 1 and Passenger, Passenger and Class 3 as well as Class 2 and Class 3 railroad organizations.

It is pertinent to note that this study depicts the cost implications of performances by different types/class of railroad organizations. There was an indication that the total costs of implementation of projects by different class of railroads were different. The significant differences in total cost indicated that the funds were not fairly distributed to indirectly benefit tax payers using public crossings at other localities in need of improvements.

The bottom line is that, the railroad organizations have different characteristics, because they have different overheads, size, manpower, and funding capacity to implement the reimbursable work, etc. Similarly, the project delivery methods were different. Hence, this could impact the outcome of the result.

However, in order to sustain and/or improve candidate HRI projects with the available funds, the New York State Department of Transportation needs to collaborate with Class 1 and Passenger railroad organizations in terms of project cost sharing. Partnering with these railroads could make them assist in providing their in-house labor or bearing part of the labor cost rather than expecting the NYSDOT to fully reimburse them for all labor, administrative and overhead costs spent on their full-time workers. As indicated by Copare (1994), the partnering is simply a relationship wherein all parties seek a common solution and ensure long term and trusting relationship so as to improve overall performance. Furthermore, while the railroad companies may claim a lack of benefits from HRI project improvements to rail operation because it only benefits highway users, they need to be aware that any derailments in the course of impact with highway vehicles could also affect the railroad organizations. With a future plan of crossing closures, the railroad organizations would want to assist to improve HRI's along the corridor. Projects involving Class 1 and Passenger railroad organizations need to be well monitored. Instead of the administrative authority relying much on submittal of bills for reimbursement, efforts should be made to adequately monitor the projects when work is in progress, particularly, passenger and Class 1 railroad organizations. This is important because in the course of performance, railroad personnel could combine railroad regular duties with HRI project and may bill all work performed during a given day or period on HRI funded projects. While efforts should be made to shorten the period of each project phase to reduce influence of inflation on cost, the billing methods should be standardized. In addition, all field changes must be approved by the NYSDOT to minimize claims. The aforementioned measures can minimize the significant disparities of total costs of the projects performed by different railroad organizations. It will allow the NYSDOT to implement more projects. Candidate crossings in other localities would be improved while HRI users who are also tax payers would be less exposed to accident risks and delays during incidents. The railroad organizations will benefit from reduced derailments and collisions with highway users, which disrupts rail operations.

As a way of broadening knowledge, this study could allow other researchers or other state departments of transportation to extrapolate or improve upon the study. The authors want the readers to note that:

- The study was limited to State/Railroad HRI contracts that were federally-funded and matched by the New York State Government
- Any errors relative to summation of cost, quantities and schedules relative to original data could affect the results of the study

- The monitoring of each highway-rail projects varies based on the presence and effectiveness of the respective NYSDOT Regional Railroad Coordinator, which can influence the accuracy of actual project input

For further comparisons, the costs could be broken down into either preliminary engineering and/or construction cost based on the need of any state department of transportation towards improving public highway-rail intersections relative to types/class of railroad organizations at pre-construction and construction phases.

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