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A Comparative Study of the Impact of Project Delivery Methods Used On Public Highway-rail Intersection Projects in New York State

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A COMPARATIVE STUDY OF THE IMPACT OF PROJECT DELIVERY METHODS USED ON PUBLIC HIGHWAY-RAIL INTERSECTION PROJECTS IN NEW YORK STATE

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ABSTRACT

The improvement of infrastructure by a public agency is to ensure satisfaction of the general public using such infrastructure, based on available funds. In order to implement and sustain the public good, an efficient project delivery method or the assessment of existing project delivery methods used to develop such infrastructure is necessary. Project delivery method is a process that defines the relationship between parties involved in a specific project. Any of the methods could affect a project budget, schedule, quality and the involvement of the project owner. This study investigated the impact of project delivery methods used by different type/class of railroad organization, which include passenger and freight railroad organizations on completed public highway-rail intersection projects in New York State, within a period of 10 years. Two hundred and fifty six (256) projects with similar scope, which were performed at independent locations, were selected. The research questions were answered based on hypotheses, which were tested with non parametric test using SPSS Statistical package version 20. The Mann-Whitney U test was used to determine the statistical significant difference between the total cost of Highway-Rail Intersection projects when Design-Build and Design-Bid-Build methods were used by railroad companies. 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, and a post-hoc test depicts the significant differences between the railroad organizations that differ. Findings indicated that there were statistical significant differences in total costs for project delivery methods as well as types/class of railroad organizations. It was recommended

that the New York State Department of Transportation should partner with the railroad organizations for 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, NYSDOT need to adequately monitor HRI projects performed by the railroad organizations.

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CHAPTER 1

INTRODUCTION

Project delivery method is a process that defines the relationship between parties involved in a specific project. The method could have effect on the project, its budget, schedule, quality as well as the extent of the owner's involvement. Kuprenas and Nasr (2007) stated that project delivery system is the term used within the construction industry to define the process by which project phases are accomplished, the contractual relationships and the parties involved in each phase.

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 based on different project delivery methods.

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 supplemented or matched by states in the United States of America. The Federal government through FHWA provides 90% of the funding while the states provide 10% as a matching fund. Where necessary, the local authorities provide funds for relocation or upgrade of the warning device system when it involves road realignments or provision of sidewalks. Certain projects under 23 United States Code (USC) 120(c) (1) allow for up to a 100% federal share for the closure of a railroad grade crossing and the installation of traffic signs and signals. In accordance with 23 USC 130(d), each state is required to conduct and systematically maintain a survey of all highways to identify railroad grade crossings that may require separation, relocation, or protective devices, and establish as well as implement a schedule of projects for improvements. At a minimum, the schedule is to provide signs for all highway-rail intersections. The U.S. DOT National Highway-Rail Crossing Inventory Program provides a uniform national inventory database that can be applied to determine the level of safety improvements at highway-rail intersections. The information can be used for planning and implementation of crossing improvement programs by public and private agencies responsible for HRI safety (USDOT –Federal Railroad Administration). The recent concern on funding public railroad crossing projects warranted maximizing available funds on HRI projects for the benefit of the public, particularly users of railroad grade crossing at various localities. In essence, the spread effect of the projects is to mitigate risks and ensure smooth operation of trains, and highway vehicles as well as safe passage of pedestrians.

According to Federal Railroad Administration (2013), New York State (NYS) has 2,679 public railroad grade crossings. As of 2009, NYS indicated 2,830 public crossings. Table 1 below shows the number of crossings based on class/type of railroads in New York State as of 2009. Despite the improvements of projects at HRI locations, the Federal Railroad Administration (FRA) encourages the elimination or closure of railroad grade crossings because of safety, cost of improvements and maintenance borne by the government and railroad companies. The elimination can be accomplished by grade separating the crossing, closing the crossing to highway traffic, or closing the crossing to railroad traffic through the abandonment of the rail line (FHWA-Railroad-Highway Grade Crossing Handbook). FRA indicated that the U.S. railroad system consists of over 750 railroads running on 140,000 miles of track. Every day, trains travel across more than 212,000 railroad grade crossings (both public and private), leading to average of 230 fatalities a year. They further indicated that 21 deaths occurred at public crossings in New York in 2012. Appendix C consists of railroad organizations operating in NYS with their acronyms and abbreviations.

Table 1.

Number of public crossings by class of railroads in New York State as of 2009

Class 1	Class 2 (Regional)	Class3 (Switching/Terminal)	Passenger (Commuter, Intercity and Tourist)	Total
1383	237	807	403	2830

Source: New York State Department of Transportation.

Schutzberg (2006) mentioned that there are over 6,000 crossings in New York State. Public crossings state-wide and private crossings on passenger and commuter rail lines are NYSDOT's first priority for safety purposes. She noted that the NYSDOT regional rail coordinators are tasked with collecting Federal reporting data on grade crossings on a regular basis. The map in Appendix D shows typical railroad grade crossings in need of improvements along the Empire State corridor between New York City and Niagara Falls. However, a public railroad grade crossing is an HRI where the roadway is under the jurisdiction of and maintained by a public authority. A private railroad grade crossing is an HRI where the highway is privately owned and is intended for use by the owner or by the owner's licensees and invitees. It is not intended for public use and is not maintained by a public highway authority (Federal Highway Administration). For those HRI's that are used by the public, projects are prioritized, initiated and improved annually based on available public funds. The projects involve installation of warning devices and surface construction. Primarily, the scope comprises of installation of flashers only, flashers and gates, circuitry upgrades and/or surface work, which consist of replacement of ties, rail, ballast and pavement or surface materials. Based on information gathered from NYSDOT, between 2002 and 2012, 75% of the number of projects completed had a project scope that involved the installation of flashing lights and gates. They were 100% funded by both Federal and State governments. These projects entail full upgrades, which requires updating existing technology with new technology as it relates to installation of warning devices and circuitry systems. Other projects involved interconnection between the railroad circuitry and highway traffic signals, as well as improvement to highway surfaces.

The HRI projects are within the railroads right of way, but the New York State Department of Transportation (NYSDOT) initiate the projects based on needs and priorities, control the funds and serve as the project sponsor through the Program Director of its Highway-Railroad Grade Crossing Safety Office. A project sponsor is defined as the person or group that provides financial resources, in cash or in kind, for the project (Project Management Institute, 2004). Federal funds are apportioned by FHWA to States while each State matches the funds in order to implement the projects. Some HRI projects are locally aided by municipalities, while those involving surfaces have shared cost agreements with the railroad organizations. Based on this, Richards (1998) indicated that the railroad and the road authority have the joint responsibility to agree upon the elevation and super elevation of both the roadway and the tracks before construction begins. Each party will be responsible at its own expense to correct deviations from the agreed upon construction plan. Projects in which the scope involves full upgrade, that is, installation of active warning equipment with flashing lights, gates and track circuitry, are federally funded, matched and administered by states based on Title 23, United States Code (U.S.C), Section 130.

In order to progress improvements, the New York State Government, through the New York State Department of Transportation (NYSDOT) enters into an agreement with the railroad organizations to perform HRI projects which are normally located within railroad organizations right-of-way. The contractual agreements between a state and respective railroads are standards which defines the scopes and responsibilities of both parties based on cost reimbursement for work performed according to agreements. However, different project delivery methods are used for the HRI projects. Hale, Shrestha, Gibson and Migliaccio (2009) indicated that various project delivery methods are currently in use today, but they cited Konchar and Sanvido (1998), who expressed that two prevalent methods are Design-Bid-Build (DBB) and Design-Bid (DB).

The project delivery methods used for HRI projects in New York State have usually been based on two different approaches. The first approach is Design-Build method used by the railroad organizations that have the force and capabilities, while the second approach is the Design-Bid-Build method or traditional method used by the railroads that do not have their own forces and capabilities. According to NYSDOT (2013), the DB force account work will be measured for payment on a dollar cent basis. Ghavamifa (2009) defined design-build as a project delivery method in which the owner procures both design and construction services while the traditional method known as Design-Bid-Build (DBB) method is when an owner procures project design through a designer and then advertises and awards the separate construction contract based on the designer's completed construction documents. The railroad companies involved in Highway-rail intersection projects are both Freight and Passenger railroad companies. The Freight railroads are classified into Class 1, Class 2, and Class 3, based on operational revenue, while the Passenger railroads are those that carry passengers either for intra-city, inter-city or tourist purposes. According to the Association of American Railroads (AAR), Class 1 railroad is a railroad with operating revenues of at least $432.2 million; Regional railroad is a line-haul railroad that has annual revenues of at least $40 million or operates at least 350 miles of road while local railroad is a railroad organization which engaged primarily in line haul service. Switching/terminal railroads engaged primarily in switching and/or terminal services for other railroads. Both local railroad and switching/terminal railroads are 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).

According to NYSDOT, based on recent increase in estimates submitted by some railroad organizations, the funds available for improving public HRI projects will not be enough to implement all candidate projects annually because the annual apportioned funds for project improvements have remained the same in recent years. In addition, there are issues with project costs relative to variations leading to the amendment of agreements with railroad organizations. State governments have been sponsoring federally funded railroad projects and have been assuming the financial risk based on the different project delivery methods applied, using funds generated from tax payers. According to CMAA (2012), each project delivery method carries a different level of risk. Rubin & Wordes (1998) stated that the risks associated with construction projects may be classified, with some overlap, as contractual or construction. Contractual risks arise from the relationship between parties. This relationship includes the legal connection created by the contract and the ongoing connection created by the interaction of the parties during the design, construction and post completion phases of the project. Construction risk can be managed through appropriate risk allocation, but it cannot be eliminated. As NYSDOT is the project sponsor with onus on the executive in charge of the HRI projects, Perkins (2005) expressed that the involved and committed executive sponsor must have enough clout to dictate appropriate processes and/or make organization changes necessary to bring about project success. The downside is that eligible Section 130 HRI projects that are federally funded and matched by the states do not mandate the railroad to contribute to the funds except voluntarily.

As mentioned earlier, various projects consist of different scope and are delivered by different type/class of railroads, with different methods. This study assessed the impact of project delivery methods on highway-rail intersections projects with the same scope, primarily those based on projects that were fully upgraded with Flashing lights and Gates in New York State. The unique aspect of the project delivery methods for HRI projects in this study as compared to exclusive highway projects, including those roadways approaching the crossing is that project performances by the railroad companies or its contractors are implemented on railroad properties, but are administered by a government entity, which in this study is New York State Department of Transportation (NYSDOT).

Background

United States Code Title 23, Section 130 (23 U.S.C. 130) provides federal funds for projects to eliminate hazards at highway-rail intersections (grade crossings) so as to reduce hazards or risk exposure to the traveling public. It is a cooperative effort between the Federal Highway Administration (FHWA), States, Railroad Companies and Municipalities where required. The highway-rail intersections are selected based on suitable method to a State, using an hazard index such as the USDOT Accident Prediction Formula to prioritize and rank the intersections with high risks and be placed on statewide funding list. The Indiana State Department of Transportation (1997) noted that the hazard index is the primary initial factor used to rank and select Section 130 projects. The highest ranked project locations are funded but limited by the appropriated amount available in each fiscal year. The Section 130 fund from the Federal Government is matched by the states. Because of the inadequate funding for all candidate crossings and increase in project estimates, available funds were only obligated for implementing projects among those that were ranked, and are top on the list. Despite this idea, the obligated funds used for the high risk projects with similar scope were assessed to determine any disparity in total costs of projects based on type/class of railroad organizations that performed the projects and project delivery methods used in order to fill the gap of shortage of funds and tackle issues relative to the number of annual projects initiated and increasing project costs. These costs are deemed to be embedded with risks and claims that require the development of amended agreements between NYS and railroads during project completion phase. The reduction in projects initiated leads to deferment of risk mitigation at the crossings. Moreover, significant differences between project delivery methods used indicated that the funds were not fairly distributed to benefit tax payers using public crossings at other localities in need of improvements.

The HRI projects considered for this study were those with similar project scope, which consists of Installation of Flashing lights, Gates and stanchions with their foundations, equipped with signal houses and circuitry systems. The projects are fully funded by the government. Other HRI projects, which are minimal, include surface work and currently require varying contributions from railroad organizations and municipalities. Likewise there are projects involving interconnection between railroad circuitry system and highway traffic signal. These interconnection projects that connects the signal systems between railroad crossing warning signals and the highway signals are performed at railroad crossings that are in close proximity to highway intersections. The surface work consists of surface materials such as rubber, asphalt or concrete materials. The scope can include tie replacement, rail welding as well as road pavement signs.

In the course of project delivery, various technologies are applied relative to project needs and success. This involves equipment and circuitry upgrades, use of prefabrications for concrete stanchion foundations, while signal houses and other devices were assembled from shops. Furthermore, software and hardware are being used for estimating, scheduling, designing, event recording of train movements to determine if installed devices generated the right warning times and identifying railroad grade crossing locations. Relative to these technologies, Skinner (1985) expressed that organizations that make products or offer services must make decisions involving their technologies when they design products or plan service. These applicable technologies for operation and implementation require management. Technology management is very important for the successful implementation of the construction and maintenance activities irrespective of the project delivery methods and the type of railroad organizations. However, they also need to be managed for cost effectiveness and value creation. Steele (1989) justified this assertion when he stated that technology management is important to the success and the survival of individual companies. Hence, the right products and services must be procured for the successful implementation of HRI projects.

As mentioned earlier, the railroad crossings are located at freight and passenger rail corridors while the projects are being initiated by the states in conjunction with railroad companies that owned the tracks and/or operate on the tracks. There is no targeted cost or specific delivery methods applicable to all highway-rail intersection projects except that it has been based on capability, where the railroad use its own force for Design-Build or use the Design-Bid-Build (conventional) method. The bottom line is that in recent time NYSDOT has been experiencing funding constraints to implement candidate HRI projects. 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 indicate a decline from year 2008. The total projects initiated, irrespective of the scope, started declining in 2008. The peak of total projects closed was very high in 2008 and the magnitude was as a result of the need of closure of various project improvements in downstate New York. However, the completed projects started declining in 2008. They can be seen in the following chart:

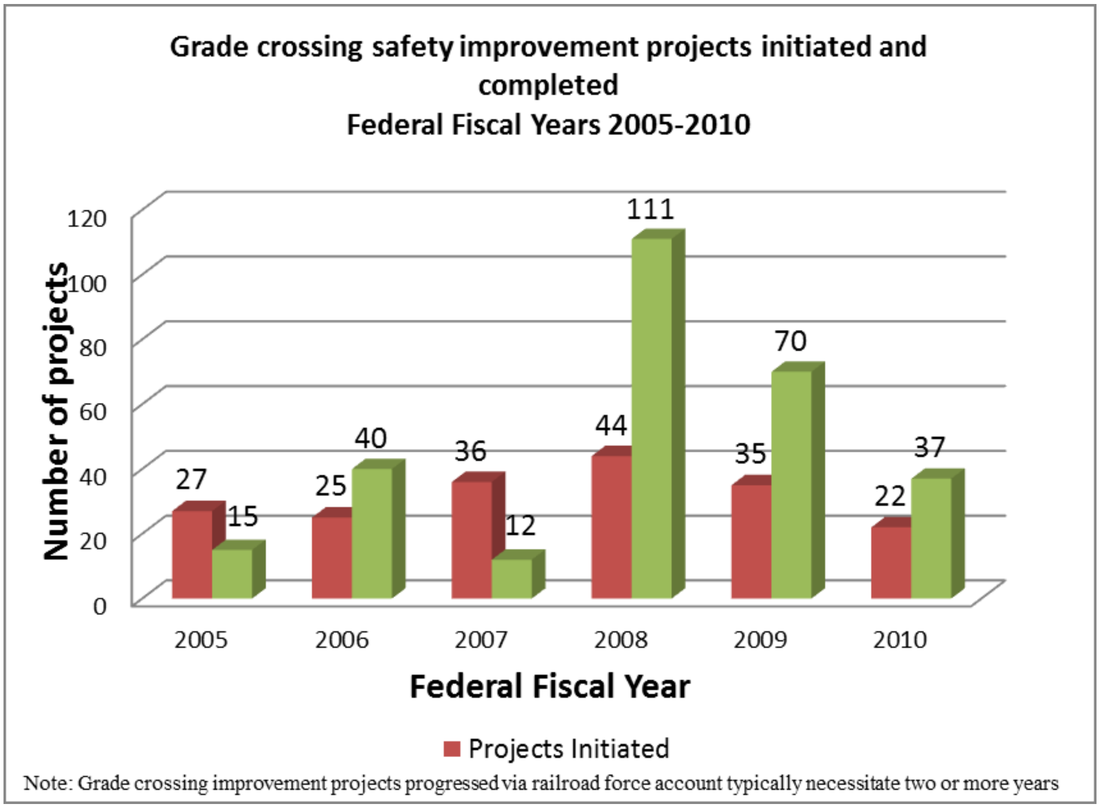


Figure 1. Show grade crossing safety improvement projects initiated and completed in Federal Fiscal years 2005-2010. Sourced from the New York State Department of Transportation

Therefore, this study looked at the impact of the project delivery methods used for the improvements of the HRI projects with the same scope in New York State

Statement of the Problem

United States Government through the Federal Highway Administration (FHWA) and States provide funds to improve highway-rail intersection projects. For this Federal Aid Project fund, which is based on Title 23, U.S.C., Section 130, the FHWA provides 90% and states provides 10% as matching funds for the projects. As indicated by the NYSDOT, in recent time, the annual funds apportioned are inadequate to implement all annual candidate HRI projects eligible for Federal Aid because of sharply escalating project cost estimates from railroad organizations. Moreover, the Department indicated that the apportioned funds of about $6 million annually have remained almost the same in the past eight financial years. The FHWA (2013) indicated that $1.6 Billion was apportioned as Federal Aid fund for all projects including HRI projects in New York for 2012 and 2013 respectively. They still projected the same amount for 2014. This amount is 4.32% of the authorized apportioned funds for all States in the US. Similarly, the FHWA –MAP 21 Fact Sheet show the Railway-Highway Crossing program funds obligated nationally for 2013 as $200 million and same amount is projected for 2014. Out of the $200 million, $6 million is still apportioned for New York State for both 2013 and 2014. In essence, this confirmed the claim of the NYSDOT. However, different project delivery methods have been applied to highway-rail intersection projects with the same scope at locations owned by different class/type of railroads.

While projects do constitute overruns, it is pertinent to determine any difference in the total cost based on its distribution when project delivery methods are used and when different types/class of railroad organizations performed the improvements. Molenaar (2004) stated that project delivery costs can be dependent upon characteristics such as level of scope definition, project complexity, owner experience, owner staffing and market characteristics. The study did not consider that project delivery costs can be impacted by the use of different project delivery methods on projects with the same scope. Therefore, the problem of this study was to analyze the impact of project delivery methods used by different types/class of railroad organizations on highway-rail intersection projects so as to provide solutions to curb any indicated cost disparity to assist the New York State Departments of Transportation (NYSDOT) and any other State DOT. This will help sustain and/or implement more HRI projects annually based on available funds provided by the Federal Highway Administration through Section 130, which are matched by the State Governments in order to reduce accident risks encountered by the traveling public.

Purpose of Study

The purpose of this study was to assess the impact of project delivery methods employed by different types/class of railroad organizations on highway-rail intersection projects in New York State so as to help improve project implementation.

Research Questions

This study answered the following research questions:

1. Is there any statistically significant difference between the total costs of Highway-Rail Intersection projects when Design-Bid-Build and Design-Build methods are used?
2. Is there any statistically significant difference between the total costs of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies?

Research Hypotheses

The following hypotheses were tested for this study:

Hypothesis 1

$H_{01:}$ There is no statistically significant difference between the total costs of Highway-Rail Intersection projects when the Design-Bid-Build method and the Design-Build method are used

H_{11}: There is a statistically significant difference between the total costs of Highway-Rail Intersection projects when the Design-Bid-Build method and the Design-Build method are used by railroad companies

Hypothesis 2

$H_{02:}$ There is no statistically significant difference between the total costs of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies

$H_{12:}$ There is a statistically significant difference between the total costs of Highway-Rail Intersection projects performed by Passenger, Class 1 (Large), Class 2 (Regional) and Class 3 (Short-Line railroads) railroad companies

Significance of Study

This study showcased disparities in the outcome of the project delivery methods used in implementing the highway-rail intersection projects funded by the government based on the same scope. According to the American Institute of Architects CES Catalogues and Topics (n.d), project delivery methods are systems used by an agency or owner for organizing and financing design, construction, operations and maintenance services for a structure or facility by entering into legal agreement with one or more parties. The State of Alaska (2004) mentioned in its handbook that public owners must be diligent in honoring the public trust while searching for the most efficient and cost effective approaches to delivering construction projects, requiring innovation and flexibility and ensure that method chosen is properly and fairly used to serve the public interest and provides quality, cost effective and timely construction. While this assertion justifies project delivery methods applied to infrastructures owned by the government such as highways, buildings, bridges, which consists of different scopes, this study focused on infrastructures/properties owned by railroad companies but funded by the government for the benefit of the public. The study looked at the impact of the project delivery methods used on highway-rail intersection projects that are similar in scope and performed on corridors owned by different types/class of railroad companies. However, because of the increase in project cost, while funding has remain stagnant over the years, the result of the study will help in equitable distribution of funding to respective highway-rail intersection projects so as to procure more projects to provide safety improvements and benefit to the public and also serving as an indicator to other states experiencing shortage of funds while using similar project delivery methods.

Limitations of Study

The following limitations exist based on available resources:

- The study was limited to State/Railroad HRI contracts that were Federally funded and matched by New York State Government
- Any errors relative to summation of cost, quantities and schedules relative to original data can affect the results of the study
- The monitoring of each highway-rail projects varies based on the presence and effectiveness of respective Regional Railroad Coordinator of the NYSDOT, which can influence accuracy of actual project input

Assumptions of Study

The following assumptions were made in order to complete this study in an effective manner:

1. The study assumed that all sourced data were accurate and did not consist of errors or be biased.
2. The study assumed that the total cost entails any risks borne by project parties and was strictly for the selected highway-rail intersection projects performed by railroads operating in New York State.

3. The projects selected were representative of all class/types of railroad companies operating in New York State.
4. The sampled project scope for selected projects is similar because they were not distinguished by type of circuitry in the NYS Grade Crossing Project database.

Definition of Terms

1. Highway-Rail Intersection: It is a location where roadway and highway systems meet on land and can be called a railroad at-grade crossing or level crossing
2. Project Delivery Method: It is a process that defines contractual relationship among parties within a specified project and how such specific project is accomplished
3. Technology: It is a tool, process, knowledge, production, upgrade and transformation of existing devices to achieve an end towards the improvement of human needs.
4. Risk: It is a situation involving the probability of occurrence of all possible outcomes, positive or negative that can be calculated or known from past experience.
5. Warning Devices: These are devices entailing gates, lights, bells installed based on varying and updated technologies at HRIs to warn (not to protect) pedestrians and motorists of approaching trains at any given time.

CHAPTER 2

REVIEW OF LITERATURE

This section looks at relevant literatures pertaining to this study. While studies on project delivery method used on highway-rail intersection projects are rare, various literatures on project delivery, funding, project scope as well as underlying theories were reviewed for discussion.

Theoretical Framework

The underlying theory for this study was based on constraint theory and theory of change.

Theory of Constraint

The theory of constraints (TOC), originally developed by Goldratt, is a management philosophy focusing on continuous improvement process. The central idea of TOC lies in the identification and exploitation of the system constraint in improving a system. TOC is based on the assumption that the performance of a system is determined by the system constraint, which is anything that blocks the system from accomplishing its stated goal, or in achieving a higher level of performance with respect to this goal (Choe & Herman, 2004). TOC can be characterized as a set of concepts, principles and measurements that focus attention on the ultimate output of the whole system, not just that of a component part of it (Dettmer, 1998). TOC determines the performance of a system (Blackstone, 2010). It is about thinking in a logical, systematic or structured process and it is an overall management philosophy (Marton & Paulova 2010). It is a systems approach that looks at every part of a system from concept to cash. Individual steps are not considered to be highest priority in the sense that TOC does not optimize a single step in a system; instead, its primary focus is to maximize the throughput of a system. TOC was originally a system for improving production capabilities of manufacturing and can be applied to other industries (Bailey, 2009). The TOC is a methodology for identifying the most limiting factors (i.e. the constraints) that stand in the way of achieving a goal and then systematically improving that constraint until it is no longer the limiting factor (Vorne Industries, n.d).

However, a constraint is anything that prevents a system from achieving a higher performance relative to its goal (Blackstone, 2010; Marto & Paulova, 2010). According to Eckstein (1961), there are many different sorts of constraints originating in various institutional or physical limitations. In a sense, they mold the analysis and give shape to the problem under study. He mentioned financial or budget constraints and emphasized that the budget constraints indicate that the amount of money available from a source is limited. HRI projects have problems of inadequate funding, which have been a major constraint that limits the number of projects implemented. The funds appropriated by Federal Highway Administration for HRI projects have remained the same over the years and by the time the NYSDOT obligates funds for projects, few projects consumed the available funds, including the 10% matched by the New York State Government. Moore and Schenkopf (1998) attested that most organizations simultaneously have limited resources and many things need to be accomplished. If due to misplaced focus, the constraint is not positively affected by an action, then it is unlikely that real progress will be made towards the goal. Hence, the NYSDOT has been prioritizing its projects with emphasis on top priority irrespective of the class of railroad based on available funds but still need better approaches to tackle the inadequacy of funds to implement more HRI projects. One of the appealing characteristics of TOC is that it inherently prioritizes improvement activities. The top priority is always the current constraint (Vorne Industry, n.d.). The bottom line is that adequate funding will be able to tackle the constraint inhibiting the progression of adequate HRI projects in New York State and allow NYSDOT to achieve its overall goal of project improvements, while the railroads or its contractors are expected to complete relevant projects on time and within budget. The concept of TOC relative to chain link indicates that each link relates to one another and it is as strong as its weakest link. In essence, the weakest link can limit the performance. The goal of the NYSDOT is to device a solution to the weakest link that limits the HRI project goal. According to Mabin (1999), Goldratt's TOC states that the overall performance of an organization is limited by its weakest link and if an organization wants to improve its performance, the first step must be to identify the system's weakest link, or constraint. The constraint for HRI project delivery can only be improved when the constraint is improved. The specific methodology TOC uses in identifying and eliminating constraints in a continuous improvement basis is referred as the Five Focusing Steps (Mabin, 1999; Goldratt and Cox 1992; Moore and Scheinkopf, 1998). It is a cyclical process and shown in the figure below:

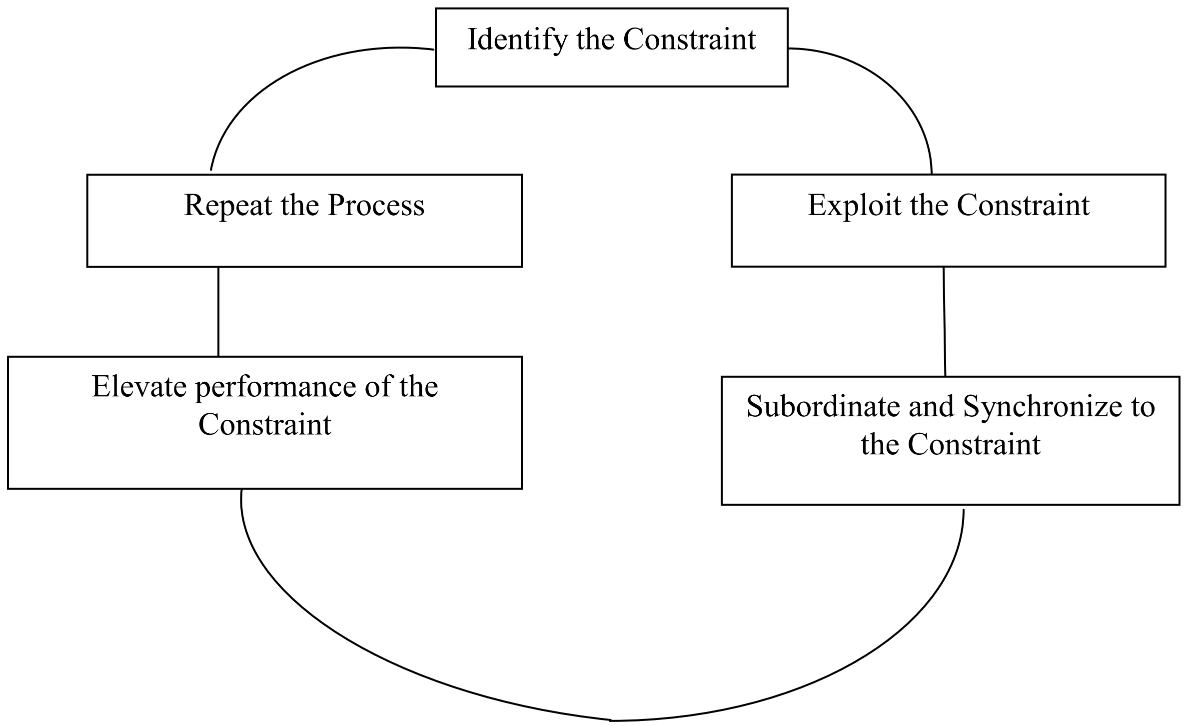


Figure 2. Show TOC that uses five focusing steps to identify and eliminate constraints. Sourced from Lean production.com, a resource of Vorne Company

Relative to the above diagram, the TOC five step process used by organizations to successfully pursue ongoing improvements is:

1. Identify the system constraint
2. Decide how to exploit the system constraint
3. Subdivide everything else to the above decisions
4. Elevate the system's constraint
5. Don't allow inertia to become the system constraint, when a constraint is broken, go back to step one.

Moore and Scheinkopf (1998) further indicated that two prerequisites must be satisfied before the five steps. They include, define the system and its purpose (goal) and determine how to measure the system's purpose. Blackstone (2010) also noted that in addition to the original five steps suggested by Goldratt, the additional two steps mentioned by Moore and Scheinkopf have been added by other authors. Mabin (1999) cited Comen and Ronen (1994) which included the two additional steps and redefined five-step as seven-step method.

The theory of constraint is a systems methodology in that it strives to ensure that any changes undertaken as part of an ongoing process of improvement will benefit the system as whole. HRI projects sponsored by the NYSDOT are continuing projects that are implemented by different class/types of railroads in New York State. For effectiveness and efficiency of the system, and to create value to all stake holders, a change undertaken in the existing process will enhance the project improvement process.

Theory of Change

A theory of change is a tool for developing solutions to complex social problems. Basically, a theory of change explains how a group of early and intermediate accomplishments set the stage for producing long-range results. A more complete theory of change articulates the assumption about the process through which change will occur and specifies the ways in which all of the required early and intermediate outcomes related to achieving the desired long-term change will be brought about and documented as they occur (Anderson, 2005). The HRI projects are government initiatives to provide improvements at railroad crossings along railroad corridors which transverse rural and urban communities. Intervention by the NYSDOT through evaluation and collaboration will help sustain the program and allow it to have positive impacts on the public within the State of New York. Weiss (1995) defined theory of change as the process that explains and give insights into how and why evaluation works. She indicated that the theory is good for evaluation relative to key aspects of programs that impact the community. She encourages program practitioners to make clear assumptions and reach agreement with colleagues on what they are trying to do. They need to be as clear as possible about not only the ultimate outcomes and impacts they hope to achieve, but also about how they expect to achieve them. Furthermore, it can help influence the theoretical assumptions existing in the current norm of project delivery.

Therefore, theory of change is a planning tool that helps organizations asks important questions about their work. It can strengthen partnerships, support organizational development and facilitate communication. It originated as an evaluation tool, and as such, explains the pathways of change that lead to the long-term goal and the connections between activities, outputs and outcomes that occur at each step along the way (Taplin and Eoin, 2013)

While adequate funding is being perceived as the primary issue of achieving NYSDOT goals in project improvements, available funds have been used to implement HRI projects which entail applicable technology that involves system upgrade, updated software and hardware, use of prefabricated and panelized materials. Although, the purpose of sponsoring HRI projects by the NYSDOT is to provide safety to communities and traveling public, the fund is like a grant given to the railroad to improve upon the system located on their properties at such locations. Mackinson, Amott and McGarvey (2006) expressed that the theory of change is a tool, which grant makers use to help themselves and their grantees understand change; that manage the change process and assesses the effects of their work. This study will tend to depict any pre-conditions that can lead to proper project delivery of the HRI projects. According to Taplin and Eoin (2013), preconditions define what has to change if the ultimate goal or impact is going to be achieved. The outcome of the change must be observable through indicators. Where outcomes are not met, interventions are applied for improvements.

The NYSDOT and the railroad companies which have crossings along their corridors need to reach a commonly understood long-term goal for annual initiation and delivery of appreciable number of public HRI projects using available government funds. In order to achieve this, a pathway of change would be required. According to Anderson (2005), pathway of change is a map that illustrates the relationship between actions and outcomes and also shows how outcomes are related to each other over the lifespan of the initiative. Keystone (2008) was quoted in Stein and Walters (2012) that "One way of presenting theory of change is through pathways to outcome diagram".

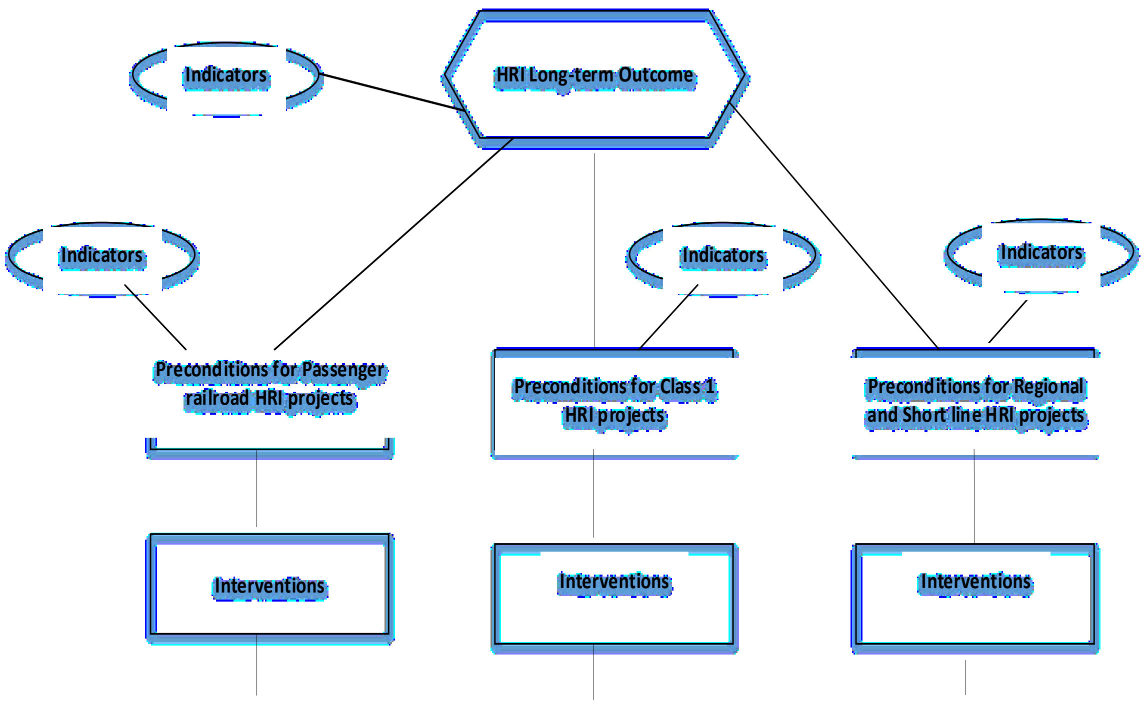


Figure 3. Show element in a pathway of change. Adapted from the Community Builder's Approach to theory of change: A practical to theory development.

As indicated by Kail and Lunley (2012) and Anderson (2005), the steps used to create a theory of change involve the following:

- Identify a long-term goal

- Conduct “backwards mapping” to identify the preconditions necessary to achieve that goal
- Identify the interventions that your initiative will perform to create these preconditions.
- Develop indicators for each precondition that will be used to assess the performance of the interventions
- Write a narrative that can be used to summarize the various moving parts of the theory.

Stein and Walters (2012) proposed that theory of change approaches can be understood across a continuum, entailing “technical tool” for planning, “thinking” for thinking about how a project is expected to work and “political literacy”, which requires understanding of how change happens, allowing practitioners to respond to unpredictable events leading to a reflexive approach to development. They identified four broad categories of theory of change, which are:

- Strategic planning: Theory of change helps organizations practically to map the change process and its expected outcomes and facilitates project implementation
- Monitoring and Evaluation – Theory of change articulates expected processes and outcomes that can be reviewed overtime. This will enable the NYSDOT and railroads to assess their contribution to change
- Description – The organizations involved will communicate their chosen change process to internal and external partners. The NYSDOT will be able to communicate any change process to the railroad companies
- Learning – It will help to clarify and develop the theory behind an organization’s program such as the HRI program statewide.

The overall goal of the NYSDOT is to be able to implement all its HRI projects in need of improvements statewide with available funds, identify preconditions towards enhancing implementation and as well intervene where necessary. Effective monitoring will depict indicators of progress in achieving successful project delivery. However, Kail and Lumley (2012), indicated that a good theory of change can reveal whether activities make sense, given the goals, whether there are things one can do that do not help in achieving the goals, which activities and outcomes can be achieved alone or not alone and how to measure the impact. For necessary intervention, which may involve relationship between the stakeholders to improve the HRI project delivery method, Mark (2008) indicated that interventions are structured to foster change at multiple levels including system, organization and community.

Project

A project is a planned set of interrelated activities to be completed over a definite period at a specified cost within a defined boundary. Lawal and Onohaebi (2010) quoted Forgarty, Blackstone and Hoffmann (1991) who expressed that a project must be goal oriented, has a definite beginning and end, had particular set of constraints and measurable output and also be able to convert one situation to another. Lawal and Onohaebi (2010) maintained that regardless of the size and complexity of a project, it is goal oriented. They further indicated that to achieve the set goal, it is important to identify and state in clear terms the problem that the project is being proposed to solve or the unsatisfied need to be met. Brenner (2007) explained that a project is not just about scope, labor hours, cost and revenue, but a project is also about the people involved in the project. One of the critical factors in a specific project is the determination of what the project entails and how it will come into reality to the satisfaction of the owner or sponsor. Watson (2009) indicated that a project must have a defined purpose which is not normally routine, or, by its nature or its uniqueness. It must set clearly defined start and end points, a time scale when the deliverables are required to be presented as well as an element of risk, because a project's unique nature touches upon the unknown and must consist of an element of managing people, perception and their respective expectations as well as a range of complex activities involving key communication issues to stakeholders. Projects must have a set of outcomes, indicating that they are objective oriented with a purpose of creating/ascertaining something new, constructing a new structure or establishing new knowledge. In addition, a project tends to challenge convention or traditional ways of doing things, working or knowledge. The Project Management Institute (PMI) also expressed that a project is a temporary group activity designed to produce a unique product, service or result. It is temporary, because it defined beginning and end in time, and therefore defined scope and resources. It is unique, because it is not a routine operation, but a specific set of operations designed to accomplish a singular goal. Therefore, a project team often includes people who do not usually work together, but could come from different organization and across multiple geographies. This is applicable to railroad organizations in conjunction with State Government Agencies and/or contractors in accomplishing highway-rail intersection projects. They are as well from different locations. While some railroads operate in New York State, with the presence of their Regional Offices, their Main Offices are located outside the State of New York.

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, because the resources have not been enough to accomplish desired projects, which is also expected to be of good quality and meets its goal of completion 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 conclusion, but now, it stands to successfully achieve its goals relative to cost, time, quality and other given criteria, which means that the goals must first be determined and thereafter compared with the achieved results. Highway-Rail projects are diversified within various railroad corridors and they either consist of the same scope or different scope. Hauc, Vrecko and Barlovic (2011), stated that as projects grow and diversify, it is essential to clarify what a successful project is, not only in terms of efficient achievement, but also in terms of rational and lasting harmless expenditure of all available and limited resources to carry out the project and influence the society. Nevertheless, organizations and managers require critical factors that need to be attended to for project performance. According to Lynch (1996), most critical factors are related to project organization, project team behavior, communication of information and contracts. They are integral parts of project delivery and demonstrate their importance for achieving a successful outcome of a project.

Since each project has a defined objective, its performance may vary or be tantamount to project design. Variability should depend on approved changes or else the available resources will be affected. Idoro (2012) indicated that project performance remains a prominent issue in project delivery because a project involves defined objectives that must be achieved and numerous resources that need to be efficiently utilized. He further stated that from the perspective of previous studies, time and cost overruns remain the prominent indications when objectively measuring a project outcome, but have limitations because their values rely on contract period and cost of project. Ismail et al. (2013) expressed that cost performance as a project indicator presents the productivity of the organization at any point during construction processes. It can be seen in the project account and is always used to measure performances. However, since a project is wide because it encompasses interrelated activities to be implemented in different disciplines or human endeavors that include construction projects such as, buildings, bridges, highways, railroads, harbors and highway-rail intersections, they can be delivered in different ways irrespective of the relationship and parties involved.

Project Delivery Methods

Project delivery method or system defines relationships among project parties and has effects on the project, budget, quality, schedule and amount of owner involvement. The aim of this method, basically, is to create value to the owner based on his satisfaction from the project initiation through when it is commissioned and occupied. Ghavamifar (2009) defined project delivery method as a framework of all project stakeholders' legal relationships and responsibilities. He looked at the decision support system for the decision makers in the transit industry towards providing information and introducing advantages and limitations of each project delivery method to the decision makers. Kuprenas and Nasr (2007) defined project delivery system as the term used within the industry to define processes by which the project phases are accomplished, the contractual relationships and the parties involved in each phase. Their study analyzed performance by the City of Los Angeles, Bureau of Engineering based on comparing the costs by phase between the Design Bid-Build method and In-house construction method. The projects analyzed are not of the same scope. They did acknowledge and stated that further research is needed for projects with equivalent design, construction scope and complexity. This study engaged highway-rail intersection projects with similar scope. Gibson, Migliaccio and O'Connor (2008) looked into developing framework using strategies for changing project delivery by organizations. It was based on case studies on government transportation projects that implements design-build methods. They used Delphi methods to validate the framework, but the study does not consider government sponsored projects performed on properties owned by different organizations such as the railroads that use varying project delivery methods in performing government funded projects.

The Construction Management Association of America (CMAA) documented that project delivery method is a system designed to achieve the satisfactory completion of a construction project from conception to occupancy. It further stated that several fundamental project considerations are directly impacted by the delivery method selected. The considerations include adherence to a realistic budget, a schedule that accurately presents the performance period, a responsive and efficient design process that leads to a quality set of documents, a thorough risk assessment followed by the proper allocation of risk by the owner and recognition of the level of expertise within the owner's organization or available to it. However, American Institute of Architects (AIA) and the Associated General Contractors of America (AGC) jointly developed a Primer on Project Delivery and indicated that the four main criteria for the success of any project delivery method are cost, quality, time and safety. The responsibilities for meeting the criteria vary by method and each project delivery method offers a different level of risk to the owner or provider. Lynch (1996) also indicated that quality, cost timeliness, responsibility and general appropriateness of the approaches are key criteria used for comparison of project delivery methods. CMAA asserts that, because of financial, organizational and time constraints, various project delivery methods have evolved to fit particular project and owner needs.

As the HRI projects are being implemented continuously, innovation of new technology warrants the upgrade of the system using the existing project delivery methods as soon new innovation emerges. Some innovations are technology based, while others, such as new products or services, are facilitated by new technology. Technology is a resource of paramount importance to many organizations and managing this resource for competitive advantage entails integrating it with the firm’s strategy (Burgelman, Madidique & Wheelwright, 1998). With the advancement of the technology, increases in prices of materials and labor costs, the project delivery methods can be influenced at varying magnitudes, leading to increases in cost of construction. Gambatese (1998) indicated that the construction industry continues to be transformed by technology advancements, changing economic climates, modified values and perceptions of design and construction. Elements stimulating the change often challenge both the boundary between design and construction as well as the borders around design disciplines and construction trades, which is typical to highway-rail intersection projects. In addition to the transformation, and based on the aforementioned, there are indications that authors have written on decision tools to help owners chose the right delivery system to match the needs and characteristics of a given project. There were few that compared specific methods used in projects. Idoro (2011) compared the levels of planning and outcome of projects procured by direct labor and Design-Bid-Build construction projects during the inception, design and construction stages in Nigeria. He found out that time overruns of the projects procured were different between the two delivery methods while the cost-overruns were the same. All the projects selected by him have completely different characteristics. Hale, Shrestha, Gibson, and Migliaccio (2009) looked into the DBB and DB methods used for Bachelor Enlisted Quarters (BEQ) of the Naval Facilities Engineering Command (NAVFAC), which were similar. They analyzed 77 projects which were divided into 39 DBB and 38 DB. They looked at the schedule and cost performances relative to number of beds in the facilities. The study did not consider the impact of the type/class or size of the contracting organization that used the delivery methods. Therefore, no study has been found to have compared project delivery methods used for HRI projects, which is serial, but this study was performed to fill a gap in the outcome of disparity encountered from the project delivery methods used on serial projects with similar scope as affected by different types of contracting organizations, depending on project cost that is embedded with all allocated risks.

The CMAA documented that a project delivery method may employ anyone or contracting formats to achieve the delivery. The methods include Design-Bid-Build, Design-Build, Construction Management at Risk, Integrated Project Delivery, Public-Private Partnership, Build Operate and Transfer, Turnkey, Fast Tracking, Partnering and Job Order. Each of these systems has varying responsibilities and risk allocation. Rubin (1998) expressed that different project delivery systems organize building process differently but each of the systems allocate risks differently.

Design-Bid-Build (DBB)

A design-bid-build contract is usually termed as a conventional or traditional method of contract. The CMAA indicated in its Owners Guide that "Traditional" is frequently used to describe the design-bid-build method, which typically involves competitively bid, lump sum construction contracts that are based on complete and prescriptive contract documents prepared by architects and engineers. Such documents include drawings, specifications and supporting information. Furthermore, it states that phases of work are usually conducted in linear sequence. This requires the owner to contract with an architect for design based on his or her brief. The design documents produced by the architect are used to secure competitive bids from contractors. Based on an accepted bid, the owner contracts with a contractor that is a low bidder to construct the building.

Parties in the Design-Bid-Build contract have been familiar with the convention, whereby the designer finalizes the entire design before inviting bidders and letting the project. DBB is characterized by a high level of competition in both the design and construction phases. All qualified designers are able to compete for the design without restriction. Likewise, design sub consultants and construction trade subcontractors can as well compete with minimum restrictions. Rubin (1998) indicated that most parties have experience with established standard form of contracts, and if disputes do arise, standard provisions are more likely to be interpreted consistently. The major risk in this method is that when the project is built in accordance with the plans and specifications, it may not even perform to owner's expectations. That is why there is performance specification, which can be different from design specification. It should be performed based on the approval of the owner for adequate compensation, while the owner bears the risk for such changes. Rubin (1998) further stated that an owner that delays performance of its responsibilities risks late completion of the project. Such delays include project requirements that change during the design process, inadequate information from owners during early stage of project, inattention to lead times required for subsurface investigations, site surveys, as well as environmental permits.

Design-Build (DB)

According to Touran et al. (2009), Design-build is a project delivery method in which the owner procures design and construction services in the same contract from a single legal entity referred to as the design-builder. This indicates that instead of the owner arraigning with multiple sources, he will arraign through a single source that will bear the responsibility for both design and construction, which will also avoid misinterpretation between the designer and the contractor. Janssens (1991) stated that one of the procurement systems is the design-build (DB), whereby the owner contracts with a single entity to perform both design and construction under a single DB contract.

Class 1 railroads and commuter railroads are large railroad organizations that have capable forces that can perform design and build. While most chose to perform design and build, some contract out the design because of the number of projects at hand. However, Rubin (2009) explained that the largest and the most sophisticated design-build firms have the in-house capability to design and construct projects without sub-contracting one or the other. He further explained that the advantage of controlling and coordinating project design and construction leads to its greatest risk. Owners with highly specialized program needs may not find it advantageous to turn over responsibility to an outside DB team without ensuring adequate levels of oversight and communication (CMAA). In this method, a railroad organization bear the

Construction Management At-Risk

The CM At-risk (CMAR) is a project delivery method which offers preconstruction services and as well as taking over similar role of a General Contractor during the construction phase. It excludes the owner from project risk. The method allows the owner to personally contact and select a Construction Manager based on past projects handled and the qualification of such Construction Manager (CM). The owner deals with the CM who provides advice to the owner before construction. As compared to the use of a General Contractor (GC) in traditional method, the selected CMAR and design team work together to develop and prepare an estimate for the project. He offers pre-construction advice on schedule, budget and methods of construction and also performs construction services. In essence, he assumes risk of delivering the project. Minchin (2009) expressed that At-risk construction management commences with the CM in an agency role for pre-construction services. Prior to construction, the firm assumes the risk of delivering the project. His assistance to designers during a design phase is helpful in project planning, value engineering analysis and specific budget.

CMAR has a commitment to deliver the project within the Guaranteed Maximum Price (GMP). While acting in the owner's interest, he absolutely ensures that the GMP is not exceeded so as to avoid loss. Minchin (2009) further indicated that, because the CM is bound to a GMP, the most fundamental character of the relationship is changed from one where the contractor is an adversary to the owner to one where the contractor and the owner are teammates. The CM at-risk hires sub-contractors directly for the project and can be liable to them based on the respective sub-contract agreements. The CMAR is also liable to project owner because he bears all risks relative to project overruns, delays, materials supplied, accidents to workmen if it exceeds insurance coverage and other hidden risks, which owner needs not bother about.

In addition to providing the owner with the benefit of pre-construction services which may result in advantageous changes to a project, CMAR offers the opportunity to begin construction prior to completion of design and negotiate with a GMP with the owner based on a partially completed design, which includes estimate of the remaining design features. It allows performance specifications or reduced specifications to be used, since its input can lead to early agreement on preferred materials, equipment types, and other project features. The primary disadvantage is a change in the contractual relationship among the designer, CMAR and owner once the price is fixed. The CMAR converts from a professional advisory role of CM to the contractual role of the general contractor (CMAA, 2012).

Public Private Partnership

A public-private partnership is a contractual agreement formed between public and private sector partners, which allow more private sector participation than is traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system. While the public sector usually retains ownership in the facility or system, the private party will be given additional decision rights in determining how the project or task will be completed (USDOT Report, 2004). The National Council for Public Private Partnership also defined a Public-Private Partnership (PPP) as a contractual agreement between a public agency (federal, state or local) and a private sector entity. It indicated that through this agreement, the skills and assets of each sector (public and private) are shared in delivering a service or facility for the use of the general public. In addition to the sharing of resources, each party shares the potential risks and rewards in the delivery of the service and/or facility (The National Council of Public Private Partnership).

Khanon (2009) expressed that Public Private Partnership has become a favorite tool for providing public services and used for developing society in both developed and developing countries. At the most general levels, Public Private Partnerships are generally recognized as long term cooperative institutional arrangements between public and private sectors to achieve various purposes. Siemiatycki (2011) also mentioned that throughout the world, public-private partnerships have become increasingly popular as a strategy to deliver large transportation projects, such as roads, bridges, tunnels, railways, seaports, and airports. While PPP has been an attractive alternative for procuring certain public works project instead of the conventional methods, Cheung and Chan (2011) indicated that because it constitutes a benefit of risk transfer which increased efficiency and innovation, and financing, governments around the world are keen to encourage PPP projects.

Various levels of government have faced an increase in public demands for infrastructure facilities, such as highways, railroads and schools while the economic growth has slowed down (Quiggin 2004, Ghavamifar 2009). This has affected available budgets for infrastructure developments and improvements. As a result, alternative sources of funding were procured leading to public-private agreements which can require sharing of risk or total risk transfer for the project. According to the CMAA *Owner's guide to project delivery methods*, PPP has gained much attention due to its ability to provide a funding option for public entities that may be struggling to identify adequate sources of capital. While this approach is a good option as a means of bringing a project to reality, it is also a very complicated and deliberate process that needs to be carefully considered. It can benefit public projects in the following ways:

- Target alternative revenue and funding sources to close a funding gap
- Allows use of low cost tax-exempt or taxable financing
- Transfers risk to the private sector
- Not subject to capital budget allocations or voter referendum
- Takes advantage of private sector efficiencies and innovations in construction, scheduling, and financing
- Provide efficiencies in long-term operations and maintenance
- Presents opportunity of combining public and private uses in mixed-use developments to leverage economic development

CMAA further indicated the disadvantages of PPP as follows:

- The owner may experience higher total life cycle costs

- The proposal process can be very expensive for all involved
- A high level of expertise is required to execute PPP project.

There is a range of options for involving the participation of private sector, which vary regarding ownership, operations and maintenance, financing, risk allocation and project duration.

The options are summarized in the following table:

Table 2.

Allocation of key responsibilities under the private sector participation options

Option	Asset Ownership	Operation and Maintenance	Capital Investment	Commercial Risk	Duration
Service Contract	Public	Public and Private	Public	Public	1-2 years
Management Contract	Public	Private	Public	Public	3-5 years
Lease	Public	Private	Public	Shared	8-15 years
Concession	Public	Private	Private	Private	25-30 years
Build Operate Transfer	Private and public	Private	Private	Private	20 – 30 years
Divestiture	Private or private and public	Private	Private	Private	Indefinite (may be limited by license)

Source: Pacific Island Forum Secretariat (2006), but was originally sourced from World Bank (1997)

Build Operate and Transfer (BOT)

The Build Operate and Transfer (BOT) approach has in recent years played a growing role in the implementation of industrial projects such as toll roads, water supply and treatment facilities in both industrialized and developing countries. It is designed and implemented as a Public-Private Partnership arrangement (Pacific Islands Forum Economic Ministers Meeting, 2006). It is a project delivery method that allows the owner, who is usually a government entity, concession a proposed or existing facility that requires construction or improvement because of lack of funding. The government agrees with the project sponsor for a number of years to build, operate to recoup investment and transfer to the government after the years in accordance with the terms of agreement. Katz and Smith (2003) state that BOT is when a government contractually grants to a private sector entity a concession requiring the entity to obtain financing for designing and building a public facility and operating the facility for period of time when the construction costs, which include profit and fees, are recovered. Chen, Lin and Wang (2012) noted that at the end of the specified operating period, the ownership of the project is transferred to the government.

In BOT, the owner can be a local, state or federal government. The concessionaire arranges for financing, getting the designers for the project and as well gets the contractor. The sponsors enter into contract with shareholders, designers, lenders and contractors. This type of project delivery method has been implemented in developing countries as well as developed countries. They are used to build infrastructures such as highways, bridges, railroads and toll booths. The owner, who is a government entity, is relieved of any adversarial relationship with the project parties and is not bothered about any costs and the risk of financing. The owners' personal fund can be redirected elsewhere for order priority expenses. Because private sectors are involved, they bring innovation and creativity into the project. It eliminates the waiting time for funds to implement a project.

Menheere and Pollalis (1996) indicated that five major participants are identified in every BOT project and Figure 4 shows the typical structure. Very simply, the principal grants the concession to the concessionaire. The concessionaire, usually a consortium of companies, undertakes the financing and development of the project. Financing is obtained from sponsors and lenders. The contractor builds the facility and the operator runs the facility.

In a BOT project, the principal is usually a government agency, a local or federal government body that recognizes the need for a public facility but is unable to financially support the project. The Concessionaire is granted a concession by the government. Financing is supplied by the sponsor through the shareholders and lenders. The concessionaire commissions a contractor with the construction of the facility. The operator, also in the concessionaire's service, manages the operational stage of the facility, and Syed, Kalaikumar, Narayanan and Nabilar (2010) noted that the facility will be operated by the concessionaire during the concession period to generate revenue to settle the debt payment and profit for the investment.

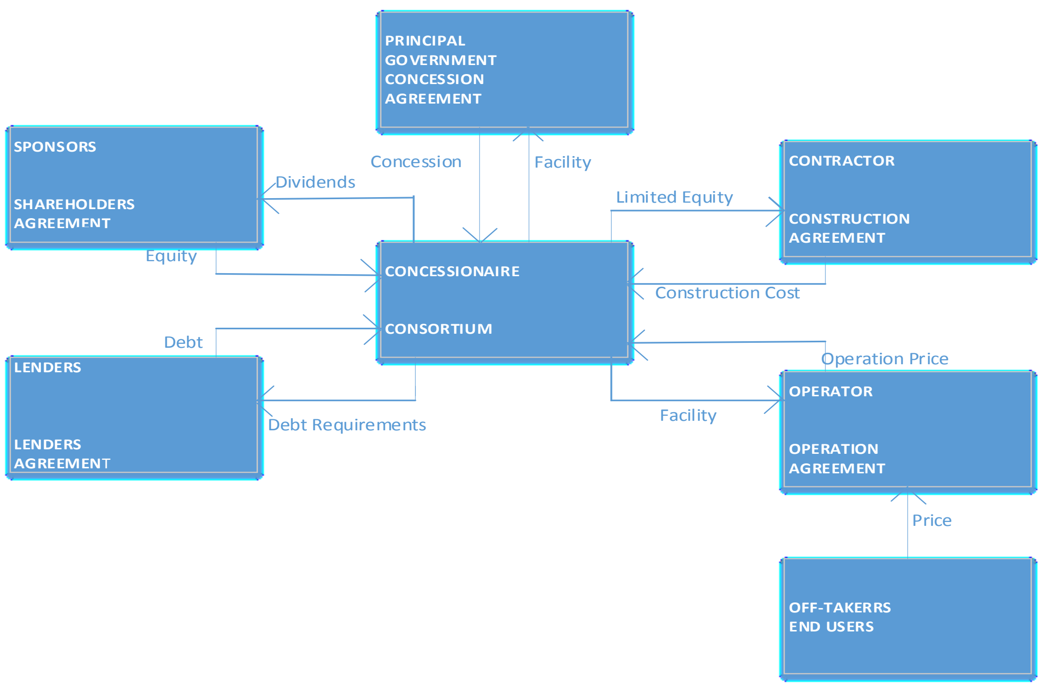


Figure 4. Show BOT organizational structure. Adapted from Case Studies on BOT, modified by R. Huijbregts after Walker and Smith.

The BOT project delivery method excludes the owner from bothering itself from all risks including financial risk. In order for the sponsor to recoup its investment on the agreed term, it will ensure that the project is properly managed to keep to schedules, control costs, and be of good quality. However, Khan, Sharif and Rehman (2012) signified that while BOT is a popular choice of infrastructure development for both government as well as private sector entities worldwide, they have varying constraints to project success, which are perceived by different stakeholders. Such constraints may be any of political, social, economic, technical, physical and ecological constraints.

Turnkey

A turnkey project means executing the project from the design phase up to commissioning and hand over. The word turnkey is used because the owner will have the plant or infrastructure ready. In a turnkey project, a single contractor assumes the entire responsibility to engineer, supply, construct and commission the project so that when it is handed over to the client, all he has to do is to only "turn the key" to start the plant or take over the operations of the infrastructure. The scope of turnkey projects normally includes detail engineering, procurement, fabrication, construction, testing and pre-commissioning, hook up, commissioning, start up and handover (Giridhar & Ramesh 1998; Menon, 1968). This project delivery method requires the owner to give out his or her brief and rely on the contractor to design, finance, construct and handover the completed project for occupation. Smith, Merna and Jobling (2006), stated that the responsibility of the contractor is to design, construct and commission the facility and sometimes include operation and maintenance, but projects must conform to clients' specifications. The owner is free from burdens and risks, but it is inflexible if the owner wishes to make amends or changes. In any attempt to make such changes, it will add more cost. In short, the owner needs to only deal with the contractor.

The nature of turnkey projects also entails the contractor to seek finance for the project in addition to responsibilities of design, construction and commissioning. The project is delivered in accordance with the brief and agreed scope. While the contractor bears the risk of construction, any changes from the original scope or addition to the project after delivery would be an extra work, which must be the responsibility of the client except for omissions or errors. Giridhar and Ramesh (1998) stated that in a turnkey project, "the purpose" is the scope of project, and any errors/omissions will constitute the part of the scope of the project and not extra work.

Middleton (2000) highlighted the advantages of the turnkey method as a delivery method that can fast-track a project, by overlapping design work with construction and installation, saving as much as 30-40% of time required for a traditional sequential project. It also generates cost savings through flexibility available to a contractor. The burden of coordination and risks and uncertainties of overall cost/schedule performance are transferred from the owner to a turnkey contractor. Menon (1968) also expressed that the turnkey method leads to efficient project execution and also saves time of completion. In addition, the dealing by clients with a single contractor on all matters establishes more effective and economic communication.

Partnering

Partnering is simply a relationship wherein all parties seek a common solution, a long term and trusting relationship, invited to openly address problems, where innovation is encouraged, needs and concerns of the others are important, and where overall performance is improved (Copare, 1994). It is a cultural approach to the organization and delivery of construction projects (Fortune & Setiawan, 2005). Partnering is viewed as an option to move construction projects away from traditional adversarial approaches to a more inclusive relationship-based model of procurement (Swan & Khalfan, 2007). It is now being used extensively in the construction industry and has stimulated considerable interest in it as a method to create better working environments (Espling & Olsson, 2004). Highway-rail intersection projects constitute serial projects that are implemented by various types of railroads within their respective corridors and can as well be implemented on a standalone basis. In essence, Eriksson (2007) indicated that partnering arrangements can be divided into two main types: short-term agreements regarding a specific project (project partnering) or long-term agreements concerning a series of projects or transactions (strategic partnering). The two types of arrangements are suitable alternatives in order to transform the traditional adversarial relationships into cooperative ones. However, project partnering targets the achievement of partnering goals and project performance, while strategic partnering opens the scope for the continuity of the reciprocity between involved parties (Barlow, Cohen, Jashapara & Simpson, 1997). It involves collaboration and parties have mutual objectives and agree on how to tackle any immediate problems as well as emanating problems in the course of the project.

Project partnering has kept dominating the construction industry due to strict procurement requirements imposed in projects initiated by government or government-funded organizations (Cowan, Gray & Larson, 1992). It is used by parties in a construction project to avoid any contracting problems. It is a managerial approach to project delivery, which will reduce burdens, losses and litigations. Godfrey (1996) stated that partnering will eliminate claims and lawsuits. Fisher (2004) explained that, while partnering is not an alternative to litigation, it is a planned process to avoid and to resolve conflict that may result in litigation. Partnering opens a process between the contract parties to have them engaged in open communications with trust and respect, and to share risk and liability responsibility for the attainment of common goals. It addresses causes of conflict such as communication, understanding of the interests of each party and solving problems related to risk and liability. Relative to public sector construction procurement, partnering often takes the form of a public policy alternative as compared to the conventional contentious and conflict-ridden process of public works construction.

Partnering improves project, reduce claims and litigation, reduce costs up to 30% and cause projects to finish on time (Espling & Ollson, 2004). Therefore, in order to build a successful partnering relationship, all parties must be honest, trustworthy, willing to do a good job, committed to create a win-win relationship, agree to each other's goals, receive support from top management in order to guide the change in direction from the old way of doing business to a cooperative way, develop formal processes that will bring any problem to a quick solution, follow up and evaluate the progress of the partnering agreement and have a plan for implementation based on mutual goals (Copare, 1994). The collaboration can eventually assist in reducing project costs.

Public Funding for HRI Projects

Highway-Rail Intersection (HRI) is either a private or public crossing. The implementation of HRI projects are funded by the public or private based on ownership and the maintainer of the roadway passing across the railroads tracks. The public highway-rail intersections are infrastructures, which when created and/or improved, are funded by the government. Fox and Smith (1990) defined public infrastructure as the physical investments such as roads, water and sewage systems, electric power plants, telecommunication facilities, railroads and airports that are traditionally provided by the public sector to private households and businesses. However, two systems interact to form HRI for use by the public. The railroad owns the right of way for its track while public highways that intersect with the track are owned by a government at different levels.

According to the USDOT-FRA Final Report (2012), the Safe Accountable Flexible Efficient Transportation Equity Act, a Legacy for Users (SAFETEA-LU), was signed into law in 2005. This legislation continued the Highway Safety Improvement Program, which set aside $880 million for distribution (over 4 years) under the Railway-Highway Crossing Program (under 23 USC 130). Projects that are eligible to be funded through the Railway-Highway Crossing Program include, but are not limited to, elimination of hazards, installation of protective devices, and grade crossing separation. The Railway-Highway Crossing Program limits the federal share to 90 percent of the project costs.

In addition to the Railway-Highway Crossing Program set-aside funds, SAFETEA-LU also makes provisions for improvements at crossings on designated high-speed rail corridors (SAFETEA-LU section 1103 (f)). Eleven corridors in the United States were identified as federally designated high-speed rail corridors. Median barriers can be installed at candidate crossings along one of the high speed rail corridors and such installation is eligible for section 1103 (f) funding. Funding levels for those eligible for 1103 (f) program are $10 million in the fiscal year (FY) 2007, $12.5 million in FY 2008, $15 million each in FY 2009, FY 2010 and FY 2011, and $7.1 million for the first 6 months of 2012.

In Title 23 USC, it indicated that subject to section 120 and subsection (b) of section 130, the entire cost of construction of projects for the elimination of hazards of railway-highway crossings, including the separation or protection of grades at crossings, the construction of existing railroad grade crossing structures, and the relocation of highways to eliminate grade crossings, may be paid from sums apportioned in accordance with section 104 of Title 23 United

States Code USC. In any case when the elimination of the hazards of a railway-highway crossing can be effected by the relocation of a portion of a railway at a cost estimated by the Secretary to be less than the cost of such elimination by one of the methods mentioned in the first sentence of this section, then the entire cost of such relocation project, subject to section 120 and b section (b) of this section, may be paid from sums apportioned in accordance with section 104 of this title.

Brown (2007) noted that the demand for infrastructure in the United States continues to grow dramatically while governments at all levels struggle to balance their budgets. The American Public Works Association (APWA) indicated that the Congressional-Chartered National Surface Transportation Policy and Revenue Study Commission found that the nation needs to increase investment to at least $225 billion annually for the next 50 years to bring the transportation system into good repair because the nation currently invests less than 40% of that amount. Grimsey and Lewis (2002) expressed that limitations in the public funds available for infrastructure have led governments to invite private sector entities into long-term contractual agreements for the financing, construction and/or operation of capital intensive projects.

The railroad and highway agencies share an interest in obtaining a safe, smooth-riding, and low maintenance crossing, but there is an inherent potential for conflict in the crossings physical design and in subsequent allocation of costs for crossing construction and maintenance. Highway agencies typically pay a substantial portion of crossing construction costs, often using Federal Highway funds to do so (TRB Report 121, 1998). The federal government provides 90% of the funding of HRI projects while the State government matched federal funds with the remaining 10%. The federal fund is apportioned to each State Department of Transportation through the Federal Highway Administration (FHWA) to implement the projects so as to reduce or eliminate crashes involving highway users with trains. According to the Public Utilities Commission of Ohio, where crossings are not eligible under the federal program, the State funded Grade Crossing Upgrade Program allows the cost of a project to be shared between local communities, the State of Ohio and the concerned railroad organizations. However, the funds received by the New York State Department of Transportation for eligible HRI projects have remained the same while the cost of project improvements has skyrocketed over the years.

Fox and Smith (1990) stated that the decline in infrastructure spending has been concentrated in infrastructures categories that involves highways. The Chartered Institution of Highways & Transportation indicated that there is potential for more public/private partnerships to deliver transport infrastructure improvements for existing development and regeneration. This is relevant to collaboration between a public agency such as the NYSDOT and the railroad corporations operating in New York State so as reduce the impact of inadequate federal funding at highway-rail intersections.

Applicable Technology

Public Highway-rail intersections consist of two transportation system components, which are the railroad track and the public road. The railroad crossings not only include the actual intersection of the track and pavement, but also the approach where physical design characteristics may have to be specifically adjusted to accommodate another transportation mode (TRB Report 121, 1998). The surface components include rails, ties, ballasts, asphalt, concrete, rubber or timber finished top surfaces. Because of frequent use of public crossings, the government provides warning devices at these locations to alert pedestrians and vehicle users of the presence of a railroad track and incoming trains based on increases in railway speeds and traffic volumes, which have led to potential increases in the risk of an accident and increases in the number of potential conflicts (Ford & Matthews, 2002). This means that HRI is one of the important rail issues that need to be given adequate consideration based on treatments. As the trains have wayside signals that control their movements, they usually do not stop at the crossings, except there is a station nearby or the operational rule is a “Stop and Proceed” at a given location. Ford and Picha (2000) states that traffic control devices are needed to ensure safety by providing for the orderly and predictable movement of all traffic. Russell and Mutabazi (1998) indicated that there are several strategies for improving the safety at grade crossing. Such strategies usually include upgrading warning devices, improving the crossing physical characteristics such as geometrics, sight distance and ride quality.

In order to mitigate risks at highway-rail intersections, warning devices are provided to alert highway users of an incoming train. Ford and Picha (2000) further stated that Traffic Control Devices are needed to ensure highway safety by providing orderly and predictable movement of all traffic. The need of the warning devices basically is to provide information to the highway user. Noyce and Fambro (1998) noted that drivers respond favorably to enhance sign system. The enhanced sign system appears to increase driver awareness when approaching highway-rail intersection.

The HRI projects are mostly improvement projects with defined scope. The project scope at railroad crossing entails surface improvements that consist of replacements of ties, rails, and surfacing such as asphalt, concrete and rubber. Full-scale upgrades involve the installation of gates, flashing lights, masts with signal house and grade crossing predictors or AC/DC circuitry. A project scope defines what a project encompasses. It outlines the complete story by describing what will and where everything will go (Lagace, 2006). The scope is the detailed description, in whatever format is appropriate to the project, of the objectives for that project, and all parties involved in a project must agree which party will be responsible for determining that all objectives for the project have been met. Early documentation of the scope and communication of that scope to all involved parties will serve to increase the chances for success on a project (Kraus & Cressman, 1992).

Technology is being applied in the improvements of HRI either in terms of construction and/or equipment upgrade. The objective of project delivery at HRIs is to insure successful project implementation and insure safety to the traveling public. Khalil (2000) defined technology as the way we do things and how we achieve our objectives. In addition, he refers technology to knowledge, products, processes, tools, methods and systems employed to create goods or provide services. While advance technology application is being used in surface construction such as the prefabrication of concrete panels rather than cast-in-place, warning devices are also being upgraded by changing incandescent lights to LED lights as well as circuitry upgrades from AC/DC to grade crossing predictors. In addition, stanchions/masts and the concrete foundation bases were prefabricated off-site and placed to avoid disruptions to traffic. Prefabrication is a form of industrialization that transfers some stages of the construction project from fields to an offsite production facility (Khalili & Chua, 2013). It uses large panel technology, which allows relatively rapid construction of large numbers of buildings at moderate unit cost (Zhao & Riffat, 2007). Project implementation also entails the use of software and hardware technology which have been applied by the NYSDOT, the railroads, contractors, suppliers and any other parties involved. They are used for designs, scheduling, estimating, mapping and identifying site locations. Likewise, appropriate equipment is used for excavation, lifting, grading, tamping and installation. Khalil (2000) expressed that technology must be recognized as strategic inputs, while key technologies must be mastered and linked into key performance indicators of an organization.

The parties involved in HRI projects used the technology for decision making as it relates to the project scope and objectives. The NYSDOT use GIS software to map and identify locations, still used CAD for sketches and detailed designs and spreadsheet for estimates and bid analyses. The railroads, contractors and consultants also use similar packages for estimating, scheduling, designs, as well as planned using appropriate hardware for project success. According to Skinner (1985), organizations that make products or offer services, must make decisions involving their technologies when they design products or plan service. However, for a successful project delivery of HRI projects, irrespective of the relationship between the NYSDOT, the railroads, the contractors and any other concerned parties or organization using available technology, the management of applicable technology is required. According to Steele (1989), technology management is important to the success and the survival of individual companies. The outcome of the project goals will justify the mission of the organization and project objectives.

Effect of Contractual Risk of Project Delivery Method on Project Overrun

The objective of any project owner or sponsor is to see that such project is complete within the specific budget and on time. It is pertinent to note that there are situations when costs exceed the contract or agreed amount based on reasons that are excusable or not. The total cost of a completed project includes any overrun that have been paid. Cost overruns affect the overall financial goal of any project because it exceeds the defined budget. El-Choum (1994) identified significant causes of cost overruns while Roachanakanan (2005) also examined causes and solutions for cost overruns of projects. As cost overruns lead to excessive cost, Ioannou and Liu

(1993) expressed that excessive construction costs have eroded the construction industry's competitive position, while many projects are being abandoned and delayed because of shortness of funds. HRI projects consist of different scope, which may vary the size of a given project. According to Flyvbjerg, Holm, and Buhl (2004), the amount of overrun in government projects is based on the size of project. The NYSDOT (2013) noted the occurrence of overrun claims, escalating project estimates and poor billing methodology as challenges. However, as mentioned earlier that there are variability in the size and type of projects that were affected by overrun, this study will analyze HRI projects that were implemented with different project delivery methods in New York State to determine if they have varying costs with the aim that the total costs included any overruns from associated risks, which may have been allocated differently. Hinze and Selsead (1991) in the Washington DOT Report indicated that cost overruns represent payment of funds that had been unanticipated in the original contract. Lundberg, Jenpantsub and Pyddoke (2011) expressed that despite all emphasis been put on improving cost calculation and reducing cost overrun, still cost overruns have not decreased. They suggested the development of risk based estimates, which should be based on principal components analysis that will use data from a developed database, which requires monitoring.

The project delivery system determines the exoneration of the risk that could be borne by parties involved in the project. Rubin (1998) expressed that each of the players in any project delivery system incurs some kind of risk at the simplest level. Because different project delivery systems organize the building process differently, each system allocates risks differently. The rigorous processes of risk identification, assessment, analysis and mitigation allow for more understanding of project risk. When risks are understood and their consequences are measured, decisions can be made to allocate risks in a manner that minimizes costs, promotes project goals and ultimately aligns the construction team with the needs and objective of traveling public. (USDOT- FHWA).

Irrespective of the project delivery method used, there will be a contract between parties involved in the project. The ultimate goal is to successfully complete such defined project. Like any other project involving construction, HRI project involves a process from the initiation stage to completion stage and can entail risks such as physical, design, construction and technology, which is based on Smith et al. (2006) classification of risk.

Table 3

Typical construction risks

Physical	Natural, ground conditions, adverse weather, as well as physical obstructions
Construction	Availability of plant and resources, industrial relations, quality, workmanship, damage, construction period, delay, construction program, construction techniques, milestones, failure to complete, type of construction contracts, cost of construction, commissioning, insurances, bonds, access and insolvency.
Design	Incomplete design, availability of information, meeting specification and standards, changes in design during construction
Technology	New technology, provisions for change in existing technology, development costs and IPR and need for research and development

Source: Managing risks in construction project by Smith, Merna & Jobling (2006)

Risk management is a form of decision making, which allows thorough understanding of a project. Its process involves identifying the risk, analyzing the risk, responding to the risk and review the risk. Katz (2001) defined risk management as the art of identifying, analyzing, responding to and controlling project risk factors in a manner which best achieves the objectives of all participants. He further stated that contractual risk transfer is a form of risk management, which has been employed for many years in the construction industry and it involves the allocation or distribution of the risks inherent to a construction project between or among contracting parties. Inappropriate risk allocation has led to adversarial relationships between contracting parties and has thereby increased the frequency of claims and disputes. Smith et al. (2006) expressed that disputes are likely to occur between the client and the contractor when the risks are not clearly allocated. However, when the risks are not identified and allocated properly, it leads to claims, which eventually results in cost overrun.

In order to avoid excessive changes in agreed amount as a result of misallocation of risks, USDOT-FHWA (2006) asserted the objectives of risk allocation, which can vary depending on unique project goals. It stated four fundamental tenets of sound risk allocation which could be followed as:

- Allocate risks to the party best able to manage them
- Allocate the risk in alignment with project goals
- Share risk when appropriate to accomplish project goals
- Ultimately seek to allocate risks to promote team alignment with customer-

Creedy (2006) indicated that the distribution of risks as reflected in various conditions of contract is one of the approaches that can redress imbalances in procurement methods. He further cited Palaneswaran and Kumarasamy (2000), that increasing demanding present-day scenarios such as scarcity of resources, growing competition, cost-benefit/value for money issues require a clear understanding of what works best and how it can be applied to implement a philosophy of continuous change and improvement in organizations. In Creedy's study, he looked at 231 completed highway construction projects solely based on traditional delivery method and noted 12 top risk factors out of 37 factors found to have led to cost overrun. They are project scope change, traffic impact during construction, disparity in contract bid price and original estimate, design scope change, increase in material cost, constructability difficulty cost, resumption/accommodation, increase in quantity service relocation. While this study do acknowledge various reasons or risk factors in the course of project implementation, both the traditional delivery (DBB) and Design-Build methods used by railroad organization for HRI projects were looked into as they affects the project costs, which are embedded by risks, in New York State.

CHAPTER 3

METHODOLOGY

This chapter focused on research methodology that was used, which includes data collection and data analysis procedures. Research methodology is the strategy that is significant to determine the way through which the objective of the research is effectively accomplished (Goddard & Melville, 2004). The study investigated the impact of project delivery methods used by railroad organizations on select public HRI projects that were completed in a period of ten years in New York State. The study examined the distribution of the total cost data for the levels of the independent variables if they were from the same population. In other words, the statistically significant differences between the total cost of completing the projects based on the project delivery methods as well as the type/class of railroad organizations were examined. The study answered the following research questions and tested the hypotheses.

Research Questions

1. Is there any statistically significant difference between the total costs of Highway-Rail Intersection projects when Design-Bid-Build method and Design-Build method are used?
2. 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?

Research Hypotheses

The following null hypotheses were tested in this study:

Hypothesis 1. $H_{01:}$ There is no statistically significant difference between the total costs of Highway-Rail Intersection projects when Design-Bid-Build method and Design-Build method are used by railroad companies

H_{11}: There is a statistically significant difference between the total costs of Highway-Rail Intersection projects when Design-Bid-Build method and Design-Build method are used by railroad companies

Hypothesis 2. $H_{02:}$ There is no 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

$H_{12:}$ 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

Research Data

Data Selection. In order to investigate the impact of project delivery methods used on railroad crossing projects in New York State, the researcher 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). 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) Grade Crossing Project database. 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 variables with categorical data are Project Delivery Method (PDM) and Railroad Organization Class (ROC). The railroad organizations were classified into Class 1, Class II, Class III and Passenger, while project delivery methods used for each project were classified into Design-Bid-Build (DBB) and Design Build (DB). The project scope, which consists of Installation of Flashers and Gates, is the same for all selected projects.

The continuous variable is a variable where the scale as mentioned above is continuous and not made up of discrete steps, or distinct points on a scale; the values between the data have meaning and the data can be broken into parts (Nelson Education, 2009). Nominal scales consist of discrete items that belong to a common category, but do not relate to one another in any particular way. They differ in name only (that is, nominally). The items in a nominal scale, in and of themselves, have no particular order and do not represent quantitative values (Few, 2005). For analysis purposes, the categorical data were coded numerically. Coding is the process of assigning responses to data categories and numbers are assigned to identify them with the categories (Smith & Albaum, 2005)

Data Entry. 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.

Statistical Data Analysis. 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 homoscedasticity, outliers and normality. The test for normality was performed using Histograms and the Shapiro-Wilk test. The Levine test was used to check for homogeneity of variance. The data collected indicated that there were outliers and extreme outliers. In addition, the data failed normality and homogeneity of variance tests.

The data were analyzed using descriptive and inferential statistical analysis. The independent variables were Project Delivery with two different levels and 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 variables are categorical.

Pappas and DePuy (2004) expressed that many statistical tests rely heavily on distributional assumptions such as normality. When the assumptions are not satisfied and tolerable, commonly used statistical tests often perform poorly, resulting in a greater chance of committing an error. When data are obtained from a non-normal distribution or contain outliers, a non-parametric test is often a more powerful statistical tool than its parametric equivalent. Because the original data failed parametric assumptions, a non-parametric test such as the Mann-Whitney U test and Kruskal Wallis test were considered. Both allow the comparison of two or more independent groups. The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed (Laerd Statistics).

The non-parametric test was used to test the hypothesis for this study because the original data failed normality test, homogeneity test and the outliers in the total project costs were greater than 5% of the data. The non-parametric test does not require satisfaction of the normality and homogeneity of variance assumptions. 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. While the Mann-Whitney U test is more commonly used for two groups, the Kruskal-Wallis test is used when there are three or more categorical, independent groups, but it can also be used for two groups. The Kruskal-Wallis test does not assume normality in the data and it is much less sensitive to outliers. It can be used when these assumptions have been violated

These non-parametric tests examined the different levels of Project Delivery and Class of railroad organizations if they were from the same population distribution. In SPSS 20, non-parametric test for independent samples was allowed to automatically choose the test based on data. The Mann-Whitney U test was used to test the statistically significant difference between the total costs of Highway-Rail Intersection projects when the Design-Bid-Build (DBB) method and the Design-Build (DB) method are used by railroad companies. It was based on the mean ranks. The medians were also reported to indicate the difference.

The Kruskal-Wallis test was used to test the 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. 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.

CHAPTER 4

RESULTS AND DATA ANALYSIS

This study assessed the impact of project delivery methods used by railroad organizations on 256 public highway-rail intersection projects in New York State. This chapter presents the results of this study by depicting both descriptive and inferential statistics.

Descriptive Analysis

The first step employed in completing the statistical test involved screening the data gathered in order to determine if there were outliers, if they were from normal distribution and any homoscedasticity. It is pertinent to indicate that all data gathered were from independent HRI projects, which were not repeated, but were designed and completed based on similar scope between 2002 and 2012. In respect to the selected projects, they constitute different Class/Types of railroad organizations which had contractual agreements with the NYSDOT but were delivered with different project delivery methods. The 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 4 shows that 74% of the selected projects were completed with the Design-Build (DB) method while 26% of the selected projects were completed with the Design-Bid-Build (DBB) method during the study period. Table 5 shows that 55% of the projects 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 4

Projects performed with different Project Delivery Methods from 2002 to 2012

PDM	Frequency	%
DB	189	73.83
DBB	67	26.17

Note: N = 256

Table 5

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

In reference to the distribution of the Total Project Cost (TPC) across the PDM and ROC, the graphical methods such as the box plots and the histograms, produced by the SPSS were looked at to investigate whether TPC was normally distributed and has no outliers for each level of the mentioned independent variables.

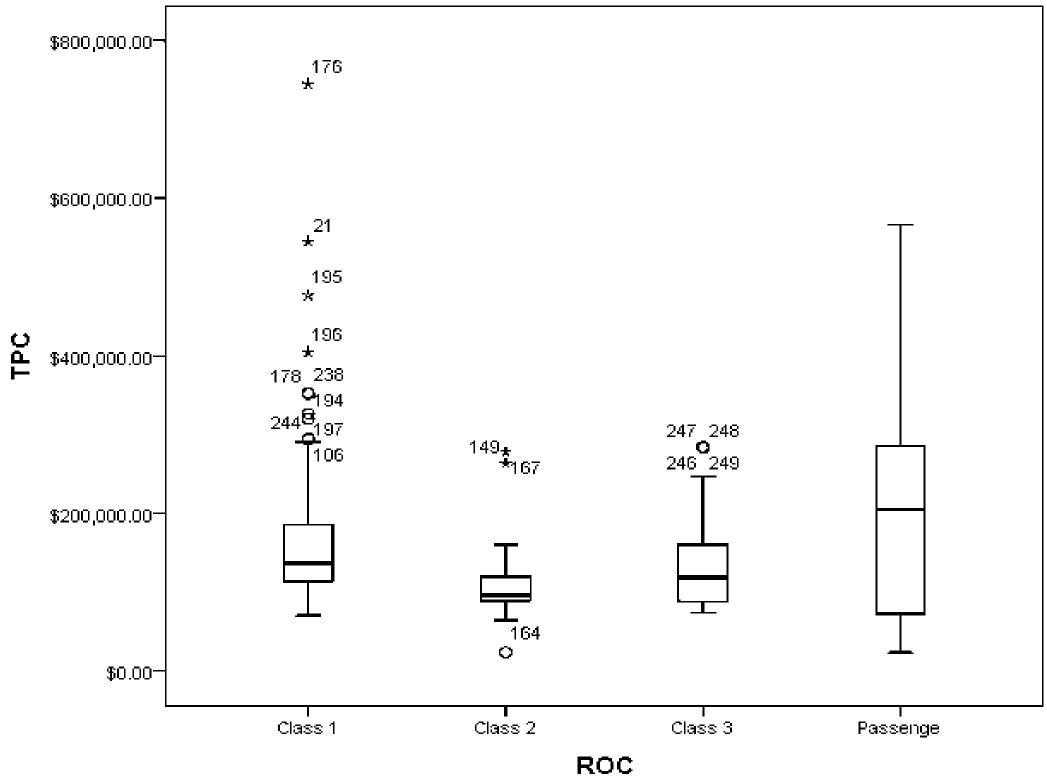


Figure 5. Shows box plots of TPC for types/class of railroad organizations

The box plots produced in Figure 5 indicate the presence of outliers across levels of class of railroad organizations except the passenger railroads. Both Class 1 and Class 2 consist of outliers and extreme outliers, Class 3 consist of only outliers. The total outliers perceived were 17.

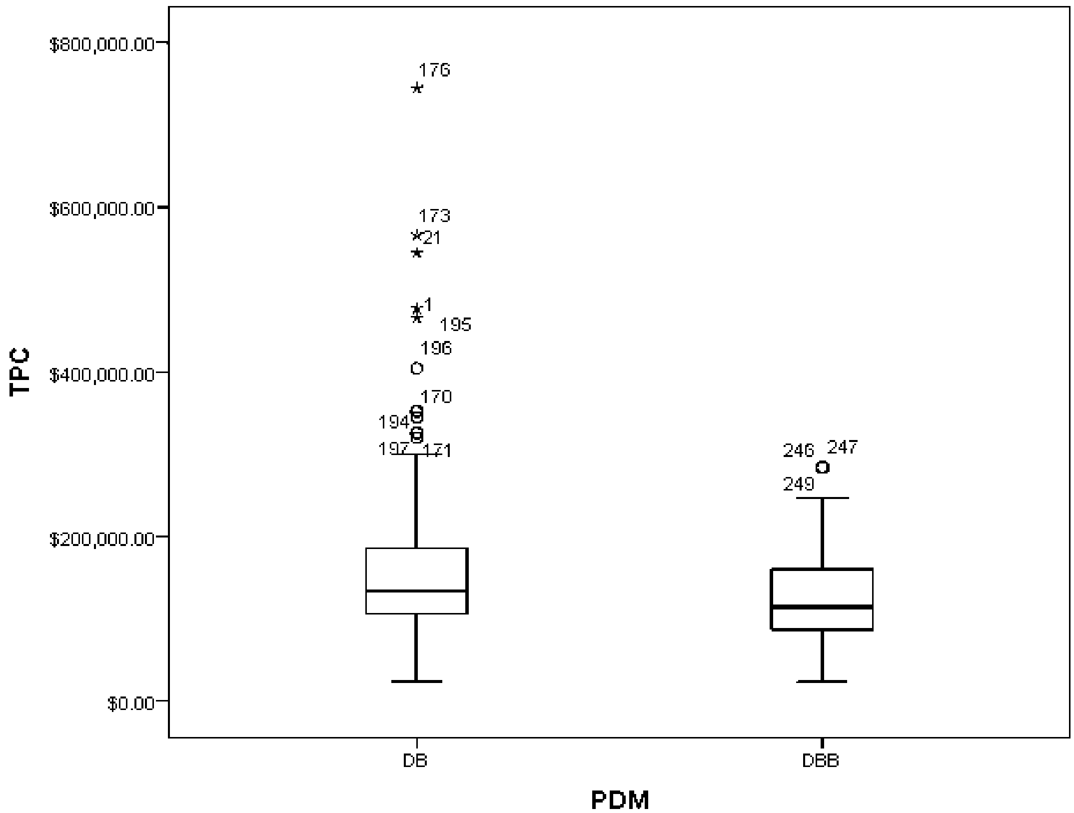


Figure 6. Show box plots of TPC for methods of project delivery

It indicates outliers across levels of Project Delivery Method (PDM). DB has outliers and extreme outliers while DBB has outliers. The total outliers shown in the box plots were 13. All the outliers indicated in the box plots are total project costs that were not gathered in error and cannot be removed

Furthermore, histograms were viewed to determine if the TPC data distributed across PDM were from normal distribution.

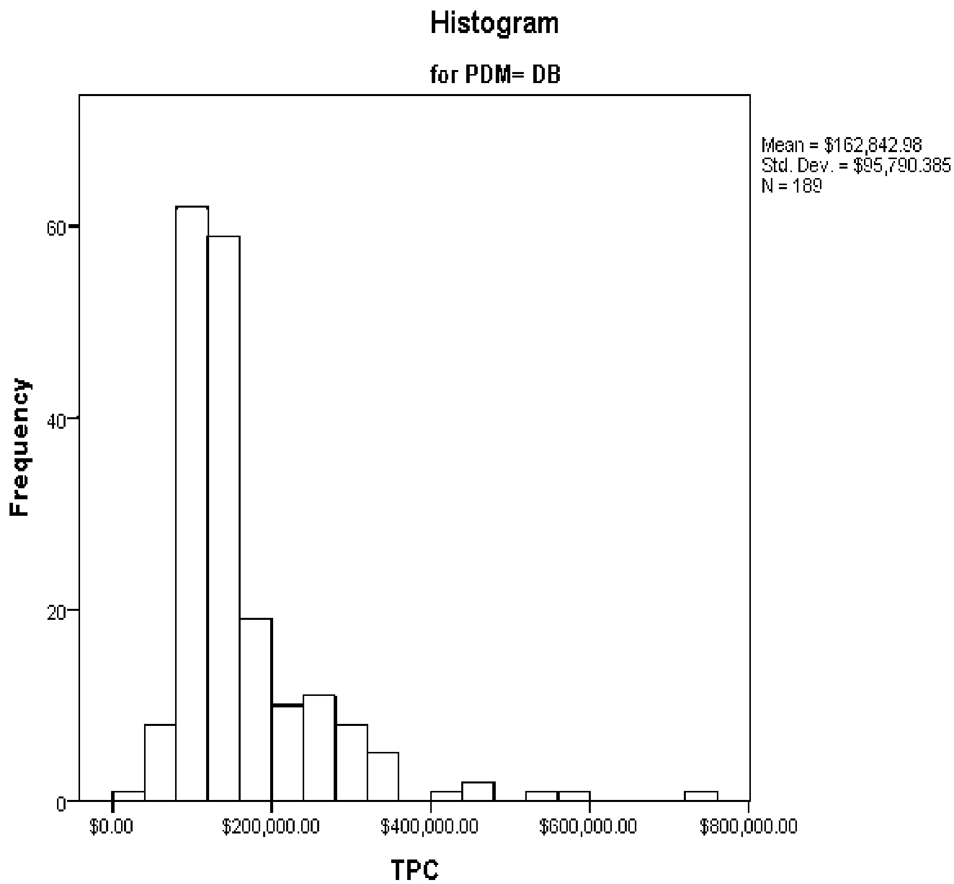


Figure 7. Histogram of TPC for when DB is used

This figure indicates the histogram when PDM =DB. It is skewed to the right and is not bell shaped. The data appears not to be normal.

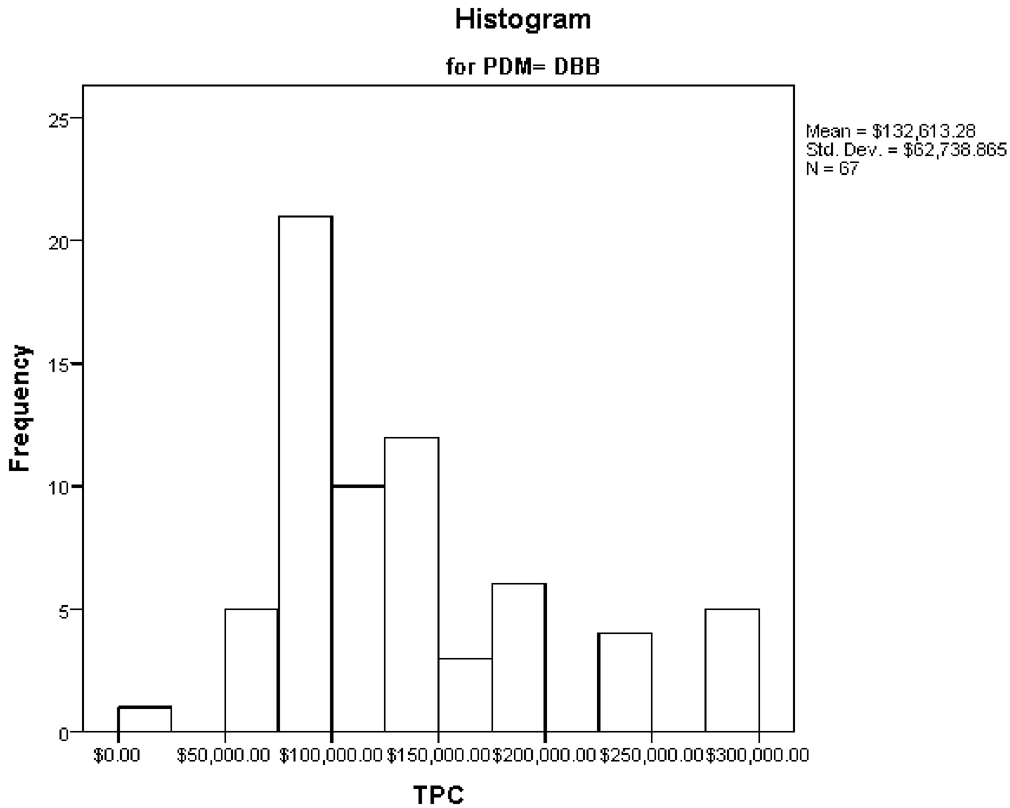


Figure 8. Histogram of TPC for when DBB is used

This figure shows when PDM = DBB. The shape of the histogram is skewed to the right. The data distribution is not normal. The histograms for TPC across the Class of Railroad were also indicated.

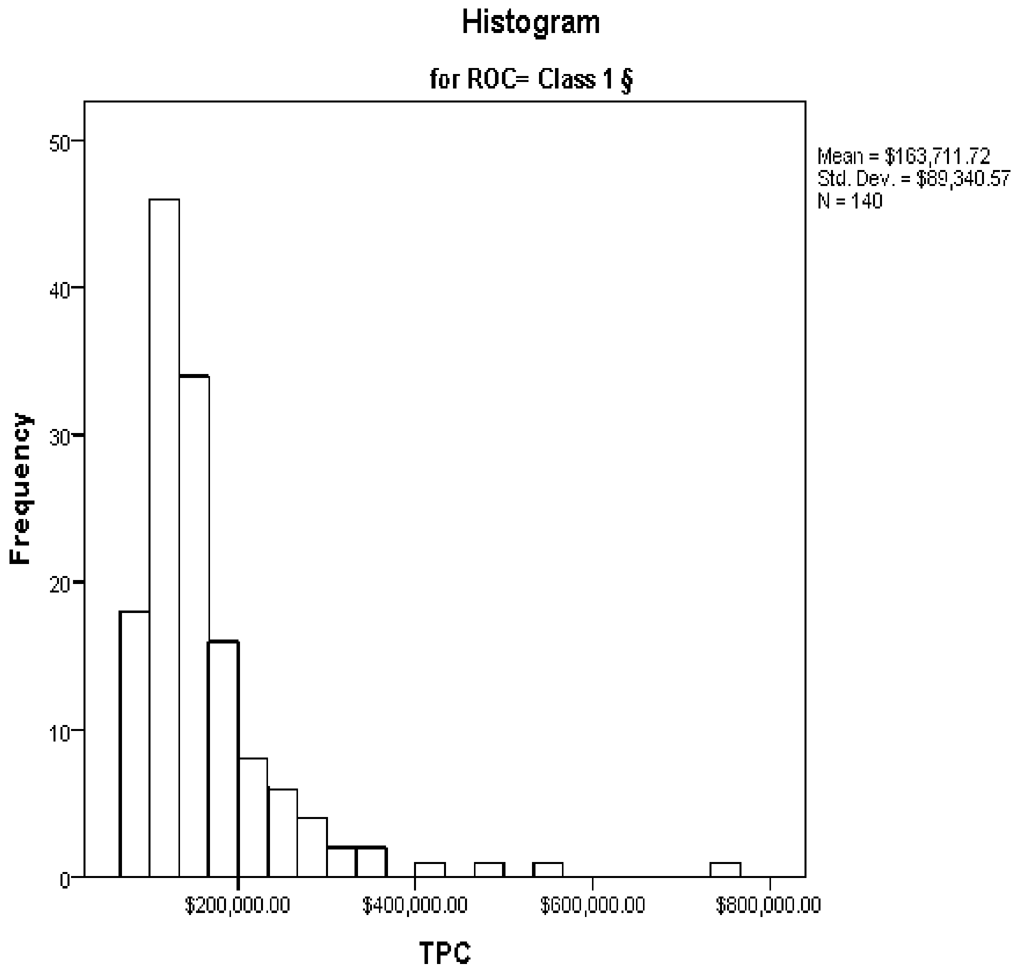


Figure 9. Histogram of TPC for Projects Completed by Class 1 Railroad Organizations.

This indicates that the total project costs when Class 1 railroad organizations performed the projects are skewed to the right.

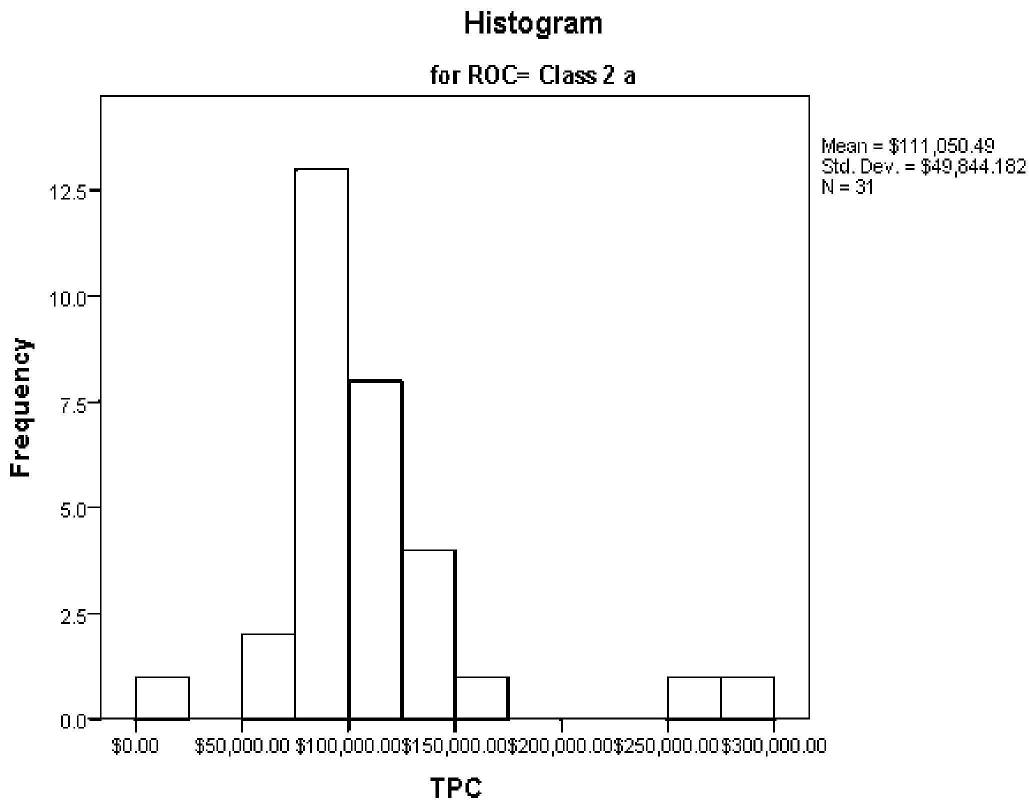


Figure 10. Histogram of TPC for Projects Completed by Class 2 Railroads

It indicates that the total project costs when Class 2 railroad organizations performed the projects are skewed to the right.

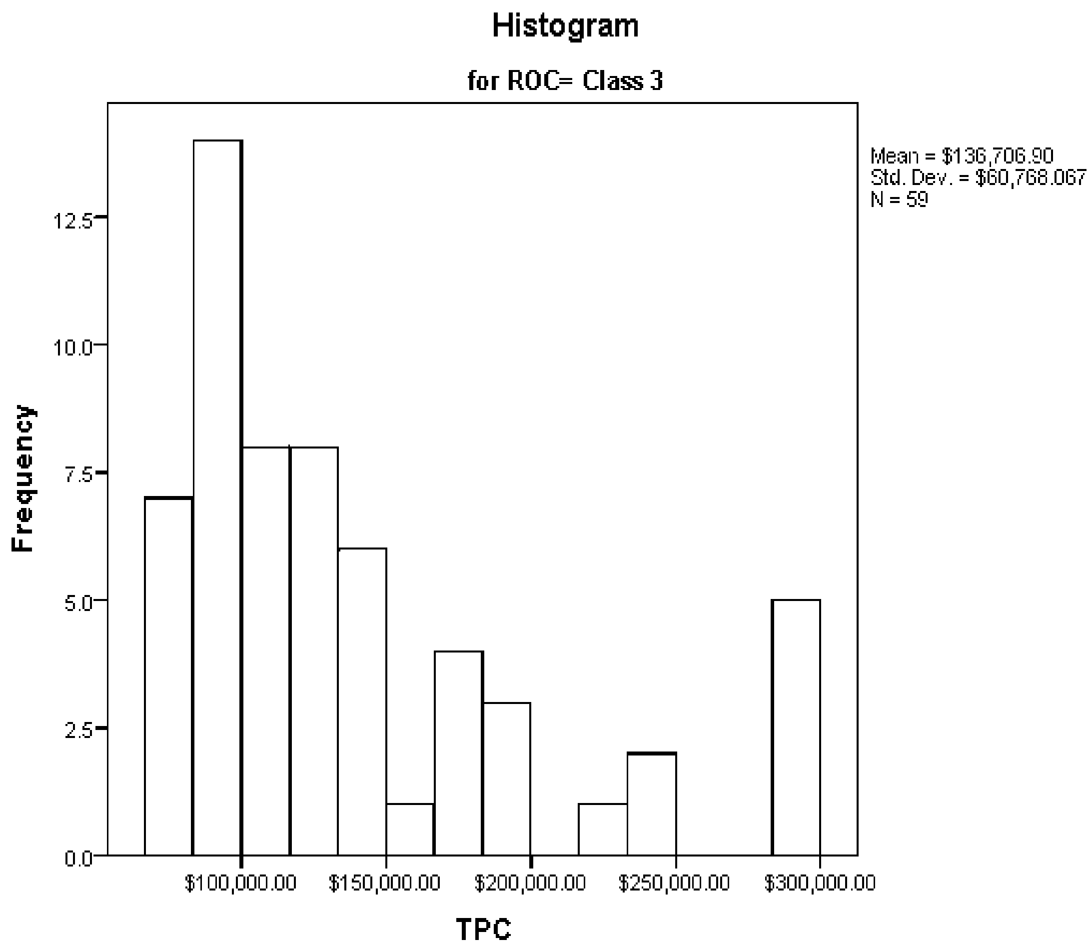


Figure 11. Histogram of TPC for Projects Completed by Class 3 Railroads

This histogram indicates the distribution of the total project costs for Class 3 railroads is skewed to the right

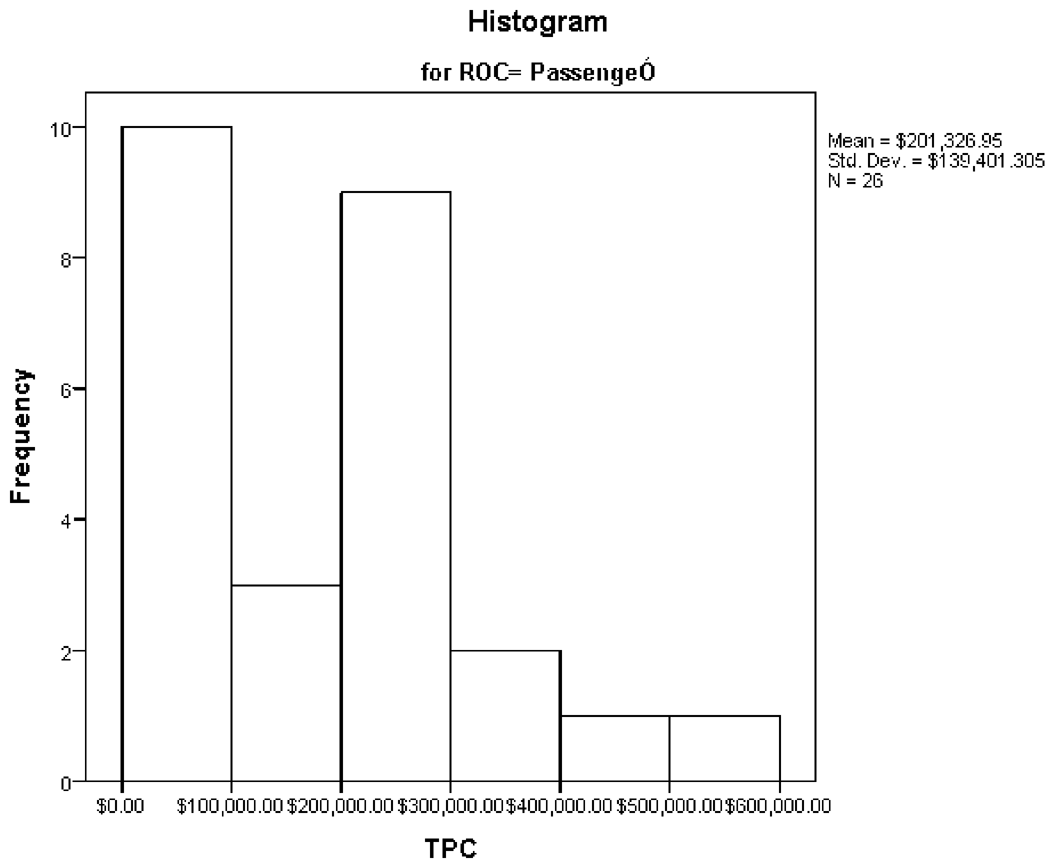


Figure 12. Histogram of TPC for Projects Completed by Passenger Railroads

The histogram indicates that the distribution of the total project costs when Passenger railroad organization performed the project is skewed to the right.

The shapes of the histograms as expressed above indicated that the TPC across the class of railroads were not normally distributed.

The Shapiro-Wilk test was also used as a numerical test to determine if the data was from a normal distribution, based on a significance level of 0.05. Table 6 indicates that the test for normality of TPC for DB as well as DBB were significant. Each of them has a significance value of 0.00. Table 7 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 6

Shapiro-Wilk Test of Normality for TPC on PDM

PDM		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
DB	TPC	.205	189	.000	.760	189	.000
DBB	TPC	.174	67	.000	.863	67	.000

a. Lilliefors Significance Correction

Table 7

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

In order to look at homoscedacity of the data, Table 8 indicates a significance of 0.002, which shows that the variances were not equal.

Table 8

Levene's Test of Equality of Error Variances[a]

Dependent Variable: TPC

F	df1	df2	Sig.
3.987	5	250	.002

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + PDM + ROC + PDM * ROC

Tables 9 and 10 were extracted from Appendixes A and B. They depict skewness, kurtosis, standard error as well as the means for project delivery methods and class of railroad organizations. The skewness for DB and DBB are greater than zero, which indicates right skewed distribution. Most values were concentrated on the left of the mean with extreme values to the right. The kurtosis for DB (9.652) is greater than 3; it is leptokurtic with peakness of distribution concentrating around the mean. The kurtosis for DBB (0.57) is less than 3; it is platykurtic with flattened tails that spread widely around the mean.

The skewness for Class 1, 2, 3 and Passenger are greater than zero, which indicates right skewed distribution. Most values were concentrated on the left of the mean with extreme values to the right. The kurtosis for Class 1 (15.08) and Class 2 (5.862) were greater than 3; they are leptokurtic with peakness of distribution concentrating around the mean. The kurtosis for Class 3 (0.808) and Passenger (0.299) were less than 3; they are platykurtic with flattened tails that spread widely around the mean. The average cost (mean 162,843) of using the DB method was more than the average cost (mean 132,613) of using the DBB method in completing HRI projects in New York State. The average cost (mean 201,326) of projects performed by passenger railroad organizations was more than Class 1, 2, and 3. The average cost (mean 163,711) of Class 1 was more than Class 2 and 3. The average cost (mean, 136,706) of Class 3 was more than the average cost (mean, 111,050) of projects performed by Class 2 railroad organizations in New York State.

Table 9

The Skewness, Kurtosis and Mean Statistics for PDM

PDM	Skewness	Std Error	Kurtosis	Std Error	Mean
DB	2.588	0.177	9.652	0.352	162,842.98
DBB	1.146	0.293	0.57	0.578	132,613.28

Table 10

The Skewness, Kurtosis and Mean Statistics for ROC

ROC	Skewness	Std Error	Kurtosis	Std Error	Mean
Class 1	3.25	0.205	15.08	0.407	163,711
Class 2	2.129	0.421	5.862	0.821	111,050
Class 3	1.31	0.311	0.808	0.613	136,706
Passenger	0.764	0.456	0.299	0.887	201,326

Analysis of Research Questions

Many options do exist for analyzing non-ideal variables. Osborne and Overbay (2004) indicated that analysts can choose from non-parametric analyses because they have few or any distribution assumptions. Therefore for validity of the result of this research, a non-parametric test was used to test the hypotheses and answered the following research questions.

Research Question 1

Is there any statistically significant difference between the total costs of Highway-Rail Intersection projects when the Design-Bid-Build method and the Design-Build method are used to implement the projects?

A Mann-Whitney U test was run to determine if there were significant differences between the total project cost of Highway-Rail Intersection projects when the Design-Bid-Build method and the Design-Build method are used to perform HRI projects. The analysis was conducted on data of the 256 selected HRI projects after it was imported into SPSS version 20.

The non-parametric test performed on the project delivery method with two independent levels, DB and DBB, using SPSS 20 depicted the result with the Mann-Whitney U test. The output of SPSS presented in Figure 13 and Table 12 indicates that the total project cost of HRI when DB (mean rank = 136.53, Median 133,316) and when DBB (mean rank = 105.84, Median 114,139) are used were statistically significantly different, $U = 4{,}813$, $z = -2.916$, $p = 0.004$. The mean rank for DB was higher than DBB. In essence, the total project costs for DB and DBB do not have similar ranked distribution. Table 12 reported that DB has higher median cost than DBB. DB is 19,180 more than DBB. Based on the p value ($0.004<0.05$), the null hypothesis was rejected while the alternative hypothesis was accepted. There was a significant difference in the distribution (mean ranks and median costs). Hence, there was a statistically significant difference between the total cost of Highway-Rail Intersection projects when Design-Bid-Build method and Design-Build method are used by railroad companies.

Research Question 2

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 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. The output of SPSS depicted the Kruskal-Wallis H test, which was presented in Figure 14 (model viewer). It indicated that the test was statistically significant at $p<0.05$. The total cost of HRI projects was statistically significantly different between Class 1, Class 2, Class 3 and Passenger railroad organizations, X^2 (3) = 23.461, *p* = 0.000. Based on the *p* value (0.00<0.05), there was at least one difference between the total cost of HRI projects performed by the different levels of class of railroads. The null hypothesis was rejected while the alternative hypothesis was accepted. In essence, SPSS report shown in Table 13 indicated that the distribution of total cost across categories of class of railroads was rejected. Hence, there was a 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

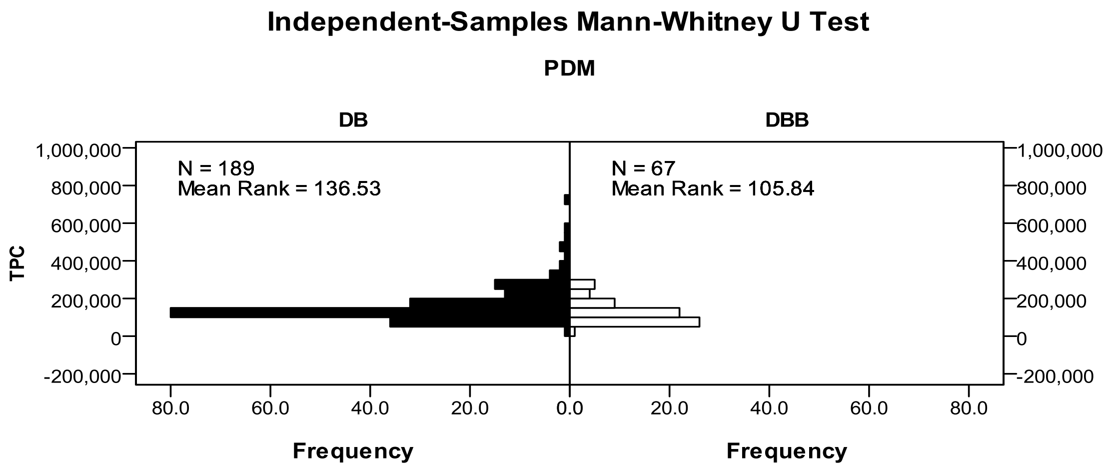
In order to determine which class of railroad organizations differs between each other, a post-hoc analysis was conducted. Pairwise comparisons were performed using Dunn's (1964) procedure with a Bonferroni correction for multiple comparisons. The post-hoc analysis shown in Figure 15 indicated that total 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 different levels of class of railroad organizations are reported in Table 14.

Table 11

Mann-Whitney Hypothesis Test Summary

Null Hypothesis	Test	Sig.	Decision
The distribution of TPC is the same across categories of PDM	Independent-Samples Mann-Whitney U Test	004	Reject the null hypothesis

Asymptotic significances are displayed. The significance level is .05



Total N	256
Mann-Whitney U	4,813.000
Wilcoxon W	7,091.000
Test Statistic	4,813.000
Standard Error	520.766
Standardized Test Statistic	-2.916
Asymptotic Sig. (2-sided test)	.004

Figure 13. Mann-Whiney U Test

Table 12

Median Report for Project Delivery Methods

PDM	TPC ($)
DB	133,316.00
DBB	114,139.08
Total	129,898.99

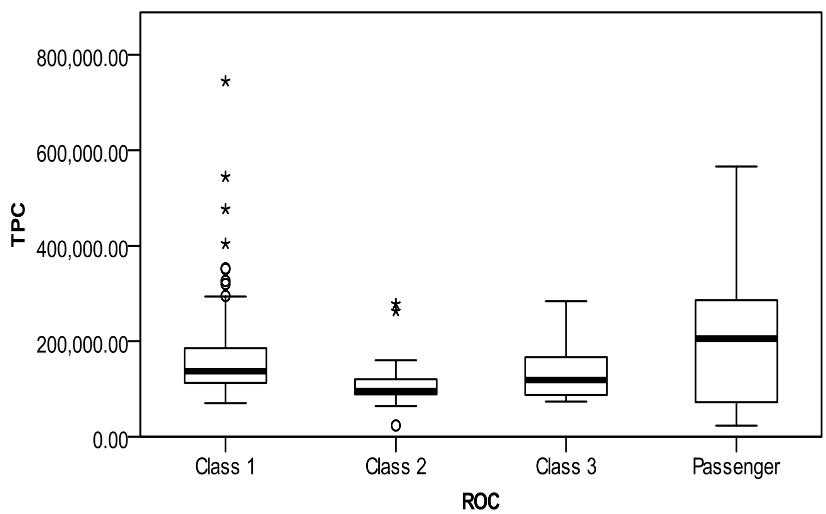
Table 13

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

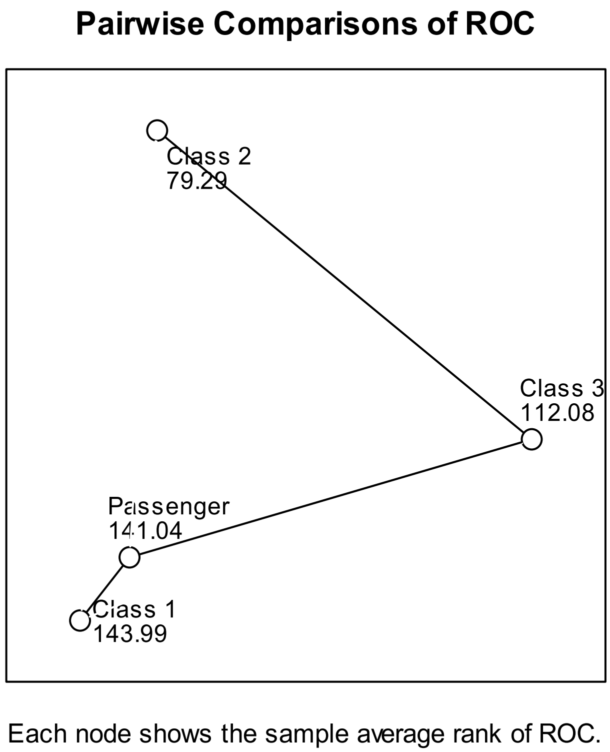
Independent-Samples Kruskal-Wallis Test



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 14. Show Model Viewer for Kruskal-Wallis Test



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.

Figure 15. Show Pairwise Comparisons of the mean rank of TPC for levels of ROC

Table 14

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

Summary

In this chapter, descriptive statistics and non-parametric test techniques were used to analyze the data for the selected HRI projects. The results were interpreted and discussed in response to the research questions of this study.

Results for Research Question 1 indicate that the total cost of HRI projects when the Design Build method and Design – Bid-Build methods were used to complete the projects were not the same. As depicted by the *p* value from Mann Whitney U test, there was a statistically significant difference between the total cost when DB and DBB are used. They are not from the same population distribution because the mean rank for DB was higher than DBB. Moreover, the median for total project cost reported for DB was higher than the median reported for DBB. The bottom line is that total cost for HRI projects when DB was used is higher than when DBB was used for a similar HRI project.

The results for Research Question 2 indicate that the total costs of HRI projects performed by Class 1, 2, 3 and Passenger railroad organizations were not the same. As shown by the *p* value from the Kruskal-Wallis test, there was statistically significant difference from the distribution of at least one group of the railroad organizations. The post hoc test revealed significant differences between Class 1 and 3, Class 1 and 2, as well as Passenger and Class 2. The bottom line is that the median of total costs of HRI projects reported for the type/class of railroads indicated the differences in the total costs of the projects they performed. Hence the null hypotheses for this study were rejected, while the alternative hypotheses were accepted.

CHAPTER 5

CONCLUSIONS

The improvements at highway-rail intersection locations to provide safety to motorists, avoid property damages and train derailments as a result of collision between trains and highway vehicles is very crucial. As the Federal government and states provide funds for improvements at these crossings, it is very important to map out strategies to manage available funds which have not really changed over the years with the increasing project estimates and total project costs. However, the project improvements need to be sustained. This study assessed the impact of project delivery methods employed by different class/types of railroad organizations on public highway-rail intersection projects in New York State, so as to sustain and help improve the implementation of more candidate projects based on available funds.

Implications of Findings

The study shows that the Design-Build (DB) method was used more than the Design-Bid-Build (DBB) method for the completed HRI projects during the ten year period. The total project costs of typical completed projects with the DB method were higher than the DBB method. There was a significant difference between the total costs of Highway-Rail Intersection projects when Design-Bid-Build and Design-Build methods were used. This could be as a result of the risk allocation in the contracts, which involved the use of the different project delivery methods by the contracting parties, the capability of the risk bearer as well as the period when preliminary engineering commenced to when costs were reimbursed. The situations where the design and construction responsibilities were performed by a railroad organization or contractor warranted higher costs as compared to the DBB method where the design and construction were procured separately. DBB allows competitive bidding, which requires conforming to bid requirements and analysis of submitted bid prior to selection of the preferred bidder. The NYSDOT approves the preferred bidder for DBB projects when compared to DB projects.

The findings also indicated that there is a significant difference between the total costs of Highway-Rail Intersection projects performed by the railroad companies. However, those that were significantly different from each other were depicted through the post-hoc analysis. 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. The Class 1 railroad organizations also primarily used the DB methods for HRI projects and assumed risks. These may have contributed to the significant difference in the total costs of projects they performed when compared to projects performed by Class 2 and 3 railroad organizations.

Findings also show that there is a significant difference 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 railroads. They are mostly located in downstate New York. Although both types of railroad organizations mostly used the DB method, the difference in the total project cost would likely be a result of difference in the type of circuitry used by each type of railroad organization, as well as administrative and overhead costs charged on the projects. There was no 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 using different project delivery methods as well as the performances by different types/class of railroad organizations. There was an indication that total costs of implementation of projects by different class of railroads were different and the project delivery methods used for all projects were not the same. 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.

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 work force. 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 in order to address the problems so that overall performance can improve. Furthermore, while the railroad companies may claim a lack of benefits from HRI project improvements to rail operation because it only benefited highway users, they need to be aware that any derailments in the course of impact with highway vehicles could also affect the railroads. Moreover, the railroads would be ready to contribute if the NYSDOT could close a crossing within a particular railroad corridor or have long term plans to grade separate potential crossings. Projects involving Class 1 and Passenger railroad organizations need to be well monitored. If NYSDOT has been mostly relying on submittal of bills for reimbursement by Class 1 and Passenger railroad organizations, efforts should be made to adequately monitor the projects when work is in progress 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 with different project delivery methods. It will allow the NYSDOT to implement more projects. In addition, candidate crossings in other localities would be improved while HRI users would be less exposed to accident risks.

Recommendations for Further Research

The researcher noted that studies on HRI projects were limited, but there were studies on project delivery methods employed on both private and public projects performed by different contractors and based on different project scope/size. This study will add to knowledge by specifically looking at the impact of project delivery methods used by different railroad organizations at public railroad grade crossings that have similar scope, particularly with limited funding. Such projects need continuous improvements at HRI locations and could assist the NYSDOT other state departments of transportation and researchers in project improvements.

However, relative to this study and aforementioned findings, depending on future requirements, the researcher recommends the following for further study.

First, HRI project database should include the type of circuitry used for full upgrades. This will be more specific in scope and help provide reasons for the differences in project costs used by different types/class of railroad organizations.

Second, the contractual obligations are usually different, particularly when different project delivery methods are employed. However, risk allocation of the contractual documents could be evaluated to determine if the appropriate party was assigned to manage such risks.

Last, as a way of broadening knowledge, this study can allow other researchers or other state departments of transportation to extrapolate or improve upon the study. As earlier indicated, the study limitations are as follows:

- 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 project delivery methods, as well as types/class of railroad organizations at pre construction and construction phases.

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APPENDIX A: DESCRIPTIVE STATISTICS OF ROC

Descriptive Statistics of ROC

	ROC			Statistic	Std. Error
TPC	Class 1	Mean		$163,711.72	$7,550.66
		95% Confidence Interval for Mean	Lower Bound	$148,782.73	
			Upper Bound	$178,640.71	
		5% Trimmed Mean		$151,884.26	
		Median		$137,108.09	
		Variance		7981737421.09	
		Std. Deviation		$89,340.57	
		Minimum		$70,353.00	
		Maximum		$744,650.00	
		Range		$674,297.00	
		Interquartile Range		$72,481.26	
		Skewness		3.249	.205
		Kurtosis		15.080	.407
	Class 2	Mean		$111,050.49	$8,952.28
		95% Confidence Interval for Mean	Lower Bound	$92,767.50	
			Upper Bound	$129,333.49	
		5% Trimmed Mean		$106,119.23	
		Median		$95,829.00	
		Variance		2484442507.54	
		Std. Deviation		$49,844.18	
		Minimum		$23,584.30	
		Maximum		$278,147.54	
		Range		$254,563.24	

	Interquartile Range		$31,661.78	
	Skewness		2.129	.421
	Kurtosis		5.862	.821
Class 3	Mean		$136,706.89	$7,911.33
	95% Confidence Interval for Mean	Lower Bound	$120,870.65	
		Upper Bound	$152,543.14	
	5% Trimmed Mean		$131,926.71	
	Median		$118,945.00	
	Variance		3692757935.69	
	Std. Deviation		$60,768.07	
	Minimum		$73,627.00	
	Maximum		$283,673.95	
	Range		$210,046.95	
	Interquartile Range		$79,024.91	
	Skewness		1.310	.311
	Kurtosis		.808	.613
Passenger	Mean		$201,326.95	$27,338.85
	95% Confidence Interval for Mean	Lower Bound	$145,021.54	
		Upper Bound	$257,632.35	
	5% Trimmed Mean		$191,834.09	
	Median		$205,246.50	
	Variance		19432723868.25	
	Std. Deviation		$139,401.305	
	Minimum		$23,197.03	
	Maximum		$566,059.00	
	Range		$542,861.97	
	Interquartile Range		$213,359.38	
	Skewness		.764	.456
	Kurtosis		.299	.887

APPENDIX B: DESCRIPTIVE STATISTICS OF PDM

PDM				Statistic	Std. Error
TPC	DB	Mean		$162,842.98	$6,967.73
		95% Confidence Interval for Mean	Lower Bound	$149,098.01	
			Upper Bound	$176,587.95	
		5% Trimmed Mean		$151,601.99	
		Median		$133,316.00	
		Variance		9175797766.99	
		Std. Deviation		$95,790.38	
		Minimum		$23,584.30	
		Maximum		$744,650.00	
		Range		$721,065.70	
		Interquartile Range		$80,716.40	
		Skewness		2.588	.177
		Kurtosis		9.652	.352
	DBB	Mean		$132,613.28	$7,664.77
		95% Confidence Interval for Mean	Lower Bound	$117,310.07	
			Upper Bound	$147,916.49	
		5% Trimmed Mean		$128,409.88	
		Median		$114,139.08	
		Variance		3936218.34	
		Std. Deviation		$62,738.87	
		Minimum		$23,197.03	
		Maximum		$283,673.95	
		Range		$260,476.92	
		Interquartile Range		$80,009.91	
		Skewness		1.146	.293
		Kurtosis		.570	.578

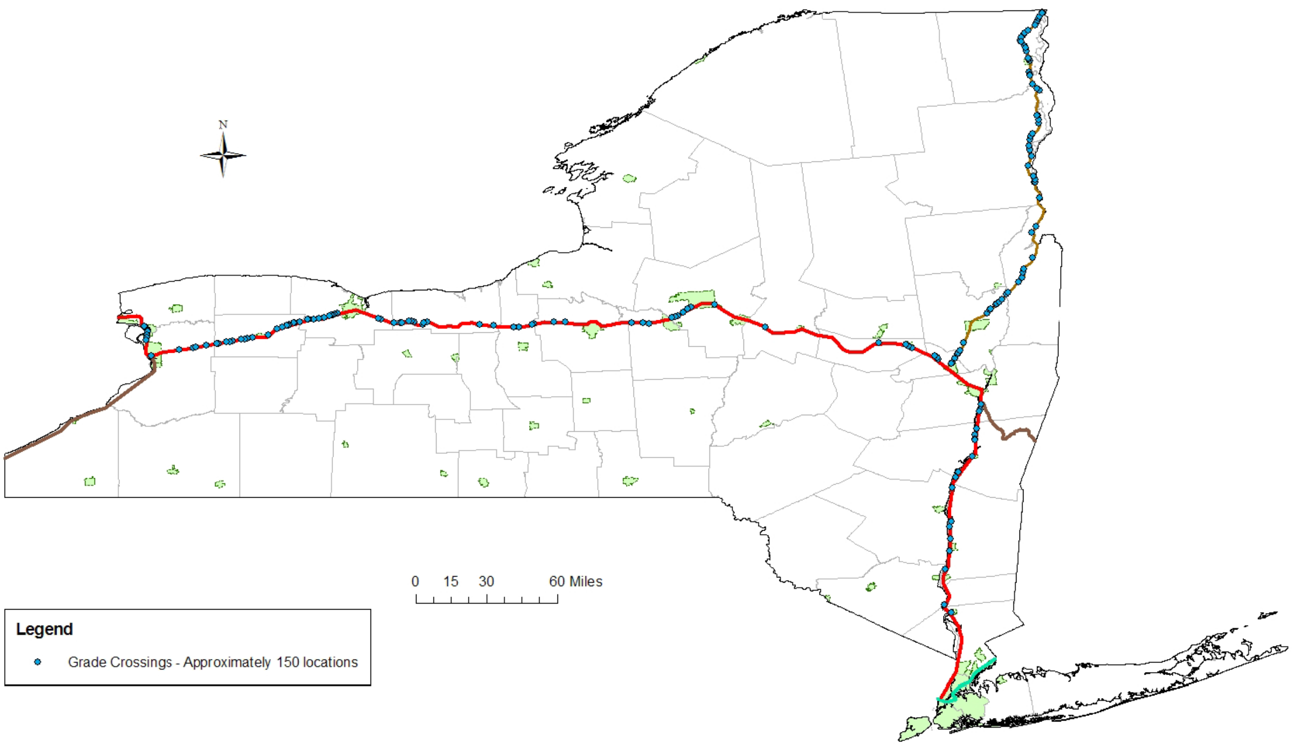
APPENDIX C: RAILROAD ORGANIZATIONS IN NYS AND ACRONYMS

Railroad Organizations Operating in New York State	**Acronyms**
ADIRONDACK CENTENNIAL RR	ADCX
ARCADE & ATTICA RAILROAD CORP.	ARA
AMTRAK	ATK
BUFFALO CREEK RAILROAD	BCK
BUCKEYE CENTRAL SCENIC RAILROAD	BCRR
BATH & HAMMONDSPORT RR CO	BH
BATTEN KILL RAILROAD	BKRR
BOSTON & MAINE CORPORATION	BM
BUFFALO & PITTSBURGH RAILROAD INC	BPRR
BUFFALO SOUTHERN RAILROAD INC.	BSOR
COOPERSTOWN & CHARLOTTE VALLEY	CACV
CLARENDON & PITTSFORD RR CO	CLP
CATSKILL MOUNTAIN RAILROAD CO, INC.	CMRR
CANADIAN PACIFIC RAILWAY	CPRS
CSX TRANSPORTATION	CSX
DELAWARE & HUDSON RAILWAY COMPANY	DH
DEPEW LANCASTER & WESTERN RR CO.	DLWR
DANSVILLE & MOUNT MORRIS RAILROAD COMPANY	DMM

FINGER LAKES RAILWAY CORPORATION	FGLK
FALLS ROAD RAILROAD	FRR
GENESEE & MOHAWK VALLEY RAILROAD COMPANY	GMVR
GENESEE AND WYOMING RR CO	GNWR
GENESSEE VALLEY RAILWAY COMPANY, INCORPORATED	GVRX
LIVONIA, AVON AND LAKEVILLE RR CO	LAL
LOWVILLE AND BEAVER RIVER RR CO	LBR
LONG ISLAND RAILROAD	LI
MOHAWK ADIRONDACK & NORTHERN RR CORP	MHWA
METRO-NORTH COMMUTER RAIL DIVISION	MNCW
MIDDLETOWN & NEW JERSEY RWY CO	MNJ
NATIONAL LEAD	NALE
NIAGARA FALLS TRANSIT AUTHORITY	NFTA
N. J. DEPT. OF TRANSPORTATION	NJT
NJ TRANSIT RAIL OPERATIONS	NJTR
NIAGARA MOHAWK POWER	NMP
NORFOLK SOUTHERN CORPORATION	NS
NEW YORK AND ATLANTIC RAILROAD	NYA
NEW YORK CROSS HARBOR RR	NYCH
NEW YORK & LAKE ERIE RAILROAD	NYLE
NEW YORK & OGDENSBURG RAILWAY COMPANY INC.	NYOG

NEW YORK, SUSQUEHANNA & WESTERN RR	NYSW
OWEGO AND HARTFORD RAILWAY	OHRY
ONTARIO MIDLAND RAILROAD CORP	OMID
ONTARIO CENTRAL RAILROAD CORP	ONCT
PROCTOR AND GAMBLE	PG
RJ CORMAN RAILROAD CO	RJCR
ROCHESTER & SOUTHERN RAILROAD INC.	RSR
SOUTH BROOKLYN RAILWAY COMPANY	SBK
STATEN ISLAND RAILROAD CORPORATION	SIRC
ST. LAWRENCE RAILROAD	SLAW
ST. LAWRENCE & RAQUETTE RIVER RR	SLRR
SOMERSET RAILROAD	SOM
UPPER HUDSON RIVER RAILROAD	UHRX
VERMONT RAILWAY, INC.	VTR
WELLSBORO & CORNING RAILROAD CO.	WCOR
WESTERN NEW YORK & PENNSYLVANIA RAILROAD LLC	WNYP

APPENDIX D: MAP SHOWING RAILROAD CROSSINGS ON EMPIRE CORRIDOR BETWEEN NY CITY AND NIAGARA FALLS



Source: New York State Department of Transportation