REPORT CDOT-2023-02 March 2023

INVESTIGATING PROJECT BUNDLING PRACTICES FOR TRANSPORTATION CONSTRUCTION PROJECTS

APPLIED RESEARCH & INNOVATION BRANCH

Yongwei Shan, Ph.D., P.E.
Saurav Shrestha
Paul M. Goodrum, Ph.D.,
P.E. Keith R. Molenaar, Ph.D.

COLORADO
Department of Transportation

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
CDOT-2023-02		

4. Title and Subtitle	5. Report Date
Investigating Project Bundling Practices for Transportation Construction Projects	March 2023
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Yongwei Shan, Saurav Shrestha, Paul Goodrum, Keith Molenaar	

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Oklahoma State University 107 Whitehurst Stillwater, OK 74078	11. Contract or Grant No. TPF-5(260) – Project 6 5260.06

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Colorado Department of Transportation - Research 2829 W. Howard Pl. Denver CO, 80204	Final
	14. Sponsoring Agency Code

15. Supplementary Notes

Prepared in cooperation with the US Department of Transportation, Federal Highway Administration

16. Abstract

Project Bundling is a contract procurement strategy that is being widely used by many State Transportation Agencies (STAs). It is claimed that project bundling can reduce project costs and expedite project delivery. To understand the current state of the practice and perception about project bundling among STA representatives as well as how practices and perceptions differ with STA's level of project bundling experience, a survey was conducted. This report presents the detailed findings of the survey, including the benefits and challenges of the bundling method. The survey found that STAs acknowledged that the project bundling helps reduce individual project costs in a bundle as well as agency administrative costs and provides an individual project with the flexibility to schedule around other projects in a bundle. Project bundling was found to have a major impact on the cost and delivery time of the project. The major factors that are considered for bundling effectiveness were found to be work type, project type, and spatial proximity. The major concern that most of the STAs had during bundling was that the bundled projects may eliminate the competition from smaller contractors. However, the concerns over the bundling method were found to be less in agencies with a high-level experience with bundling. The survey also found that the majority of STAs have not quantified the impact of the project bundling. However, some STAs are in the process of collecting adequate data as they continue practicing bundling so that they can quantify. To help STAs to implement project bundling more efficiently, a semi-structured interviews and follow-up correspondence with 16 representatives from different STAs and a public agency was conducted to extact best practices. The study found that there are different variations of project bundling strategies (for instance, optional-tie or mandatory-tie) and bundling approaches (scope-based or location-based) utilized by the agencies. In the end, the best practices of project bundling are presented as a flowchart to help STAs better implement project bundling.

17. Keywords	18. Distribution Statement
Project Bundling, Highway Construction, Bridge Construction, Best Practices, Contracting	This document is available on CDOT's website https://www.codot.gov/programs/research

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	135	

EXECUTIVE SUMMARY

Project bundling is one of the Every Day Counts -5 (EDC-5) initiatives. Project bundling for bridges has been empirically documented by various state transportation agencies (STAs) to have the benefits of reducing overall construction costs, shortening project delivery, and reducing staff time for paperwork and contract administration through bundling multiple smaller projects of similar nature within their proximity into a single larger contract. The efficiency in project delivery, costs, and the level of staff requirement arises from the economy of scale through bundling. Recently, FHWA developed a guidebook on project bundling with a primary focus on bridge projects. In that guidebook, a wealth of knowledge and practices were extracted from case studies of the various pilot and regular bridge bundling projects from different STAs. This study is meant to investigate the project bundling practices being implemented at a broader scale, including bridges and other types of projects so that best practices can be distilled to benefit STAs at a broader scale.

This report provides a summary of the state-of-the-practice in project bundling implemented on various types of transportation construction projects, documents the perceived benefits and challenges associated with project bundling, and synthesizes best practices of project bundling among STAs. The findings of this study were based on a literature review, an electronic survey of 35 STAs conducted in 2020, and follow-up interviews and case studies with 16 representatives from different STAs conducted in 2021.

The electronic survey found that:
The project bundling has been widely used by STAS on bridge projects, roadway, and safety projects. Project bundling can work with different project delivery methods. The interstates and high-volume roadway projects located in the same corridor are often bundled while bridge bundles can be expanded to a larger geographical area. The bundling practices differ depending on the scope, geographic distribution, and design. The majority of the STAs assess projects' suitability for bundling as early as the planning and programming phases. The major factors that are considered during bundling by STAs include work type, project type, and spatial proximity. However, as STAs gain more experience in project bundling, project risks are often evaluated more in bundling decisions.

The majority of the STAs perceive no difference in the risks associated between bundled and non-bundled projects. However, some reported that delay in the design of a single component in a bundle when other components are ready can further delay the entire bundle and that the project complexity can be occasionally compounded by the bundling, resulting in schedule delay and cost overrun.

The majority of the STAs agreed on the benefits of project bundling, including reducing the cost of individual projects in a bundle, saving administrative costs, reducing project delivery time, and allowing for individual projects' flexibility in scheduling. However, few STAs have

officially quantified the impact of project bundling. The major concern associated with project bundling lies in the potential elimination of competition from smaller contractors.

The open-ended follow-up interviews with 16 STA representatives found that:
The main objective of bundling for the majority of the STAs is to achieve efficiency in project delivery by combining similar types of projects in a bundle, such that cost and time savings can be achieved. Various funding sources have been strategically utilized by STAs to fund those bundled projects.

Project bundling strategies come in different "forms and shapes." Other names, such as grouping, project ties, and combined projects, have been used by different STAs. Case studies on unique project bundling practices from Oklahoma, Nebraska, and Iowa State DOTs are presented in the report.

The common bundling approaches adopted by STAs are scope-based and located-based. Other factors, such as construction schedule, public convenience, environmental permit and utility relocations, and similarity in design, are often considered in both approaches.

Few STAs have collected data on the quantification of the impact of project bundling. However, the analysis of some data collected by the Oklahoma Department of Transportation indicated that 0-20% of the cost savings can be realized through project bundling and bundled projects tend to attract more bids.

Advanced project bundling users tend to incorporate formal risk assessment procedures into their bundling practices. Risk management tools used by STAs are reviewed in this report.

Based on the findings of both the electronic survey and the follow-up interviews and case studies, the best bundling practices that were successfully implemented by the STAs during the planning, programming, and design stages were synthesized as a general project bundling framework for STAs' reference.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Background

Project Bundling is a contract procurement strategy that is being widely used in bridge and highway projects. According to the Federal Highway Administration (FHWA) *EDC-5 Resource Guide*, project bundling is a process where multiple rehabilitation, repair, replacement, or preservation projects are combined to form a single larger contract (*1*). The FAST (Fixing America's Surface Transportation) Act in 2015 added the definition of "Bundling of bridge projects" in Section 144 of title 23 stating the purpose of bundling is to save time and cost (*2*). A

single contract is awarded to the contractor which includes multiple projects of similar category and size. The method of bundling smaller projects into one contract has also been recognized as one of the most effective strategies to reduce construction costs (*3*).

The definition and terminology of project bundling, however, is not universal as it varies from agency to agency. Xiong et al. (*4*) in their study, have used the term Project Grouping as an alternative to project bundling. The Federal Acquisition Regulation (FAR), Section 2.101, has introduced the term consolidation and defines it as a process of combining two or more projects that are provided to or performed for federal agencies at two or more discrete sites. Federal Acquisition Regulation (FAR 2.101) also defines project bundling as a subset of contract consolidation in which two or more projects that have been previously performed by a small business under separate contract are bundled into a single contract that is not suitable to award to small businesses due to various factors such as size, geographical locations, and aggregate dollar value of the anticipated award (*5*). Similarly, United Nations Framework Convention on Climate Change (*6*), in its Executive board meeting report, has introduced the term Sub-bundle which is defined as the process of combining Clean Development Mechanism (CDM) projects that are within a bundle, sharing the same project characteristics and type.

The majority of the State Transportation Agencies (STAs) have utilized the project bundling for bridge projects (*7*). The survey conducted by AASHTO Committee on Construction (COC), Contract Administration (CA) Section in 2018 reported that the STAs mostly used bridge bundling and documented the benefits of reducing overall construction costs, shortening project delivery, and reducing staff time for paperwork and contract administration. The guidebook developed by FHWA on project bundling also provides a wealth of information on project bundling (*8*). However, the guidebook is primarily focused on the project bundling practices that STAs adopted for bridge projects. Roadway projects (such as added travel lanes, resurfacing, intersection improvement, interchange work, shoulder rehabilitation and repair, etc.) and other construction projects were not covered by the guidebook. Thus, a knowledge gap in project bundling might be discovered through the survey and analysis of STAs' implemenation practices of project bundling followed by case studies.

1.2 Objectives of the Study

The main objective of this study is to explore the current state of practices of project bundling among various STAs including but not limited to bridge projects. The study will be conducted through a survey and case studies of various STAs that are utilizing the project bundling method. The following objectives will be achieved during the study:

i. Synthesizing the literature on current practices of project bundling among various STAs;
ii. Reviewing and synthesizing the current experience of STAs with project bundling for various construction projects;
iii. Developing a flowchart for best project bundling practices.

1.3 Methodology

To meet the objectives of the study, the research is performed in two phases:

- Phase I: State of the Practice Survey
- Phase II: Follow-up Interviews and Case Studies

The first phase of the study "State of the Practice Survey" was a survey with both closed-ended and open-ended questions. An electronic survey was conducted to collect information about the current state of the practice and perceptions about project bundling from various STAs. The survey questionnaire was designed in an online survey platform, Qualtrics, and an invitation to participate in the survey was forwarded to all the AASHTO Committee on Construction Members in 2020. The participants of the study were all STA representatives. After the collection of the data, statistical inferences were derived relative to the objectives of the study. An appropriate statistical analysis method was performed to analyze the quantitative survey data.

The second phase of the study "Follow-up Interviews and Case Studies" was a qualitative research study. The study was performed by conducting an online interview with representatives from different STAs. An open-ended questionnaire was prepared to collect the data, including the perception of the participants towards the project bundling based on the experience they gained while utilizing the project bundling. The interviews were recorded with consent from the participants. The recorded interviews were then transcribed and imported into a qualitative

analysis software, NVivo. Deductive reasoning was adopted to generate codes. The coding of the data was based on the literature reviews and the data obtained from the interview. A reference to the data collected from the first phase of the study will also be taken into consideration. The codes are then categorized into major themes of the study that will reflect the best practices for the project bundling method, including the definition of project bundling, bundling goals or objectives, general approach to bundling decision, the impact of bundling, assessment of projects' suitability for bundling, unbundling strategies, risk management, consideration for smaller contractors, and funding sources.

1.4 Organization of the Report

The report consists of five chapters:

1. Chapter 1 discusses the motivation of the research, the basic information about project bundling, and the objectives of the study.
2. Chapter 2 synthesizes the literature about the current project bundling practices. It discusses various projects that were successfully completed by STAs utilizing the project bundling method. The benefits and challenges faced by STAs during the bundling are discussed in detail.
3. Chapter 3 presents the first phase of the study: *the State of the Practice Survey*. It discusses the findings of the survey about the current state of the practice and perception of project bundling among State Transportation Agency (STA) representatives.
4. Chapter 4 provides a detailed report of the second phase of the study: *Follow-Up Interviews and Case Studies*. Then, an synthesis of the best practices for project bundling is provided.
5. Chapter 5 includes the conclusions of this study as well as recommendations regarding project bundling that will help STAs better implement the method in various project types beyond bridge projects.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview

The project bundling method has been effectively put into practice in various transportation projects by many STAs (*7*). In the survey conducted by the American Association of State Highway and Transportation Officials Committee on Construction Contract Administration (AASHTO COC CA) Section in 2018, the project bundling method was found to be used mostly on bridge projects, such as bridge repair, rehabilitation, maintenance, and new construction (*7*). It was also found that very few STAs have developed a bundling guideline while the majority of the STAs had not measured the effectiveness of the project bundling.

Currently, there have been very few studies that measure the effectiveness of project bundling. The major studies that contributed to the effective application of the project bundling method have been discussed in detail in this section.

The main objective of this literature review was to collect indispensable information about project bundling practices as well as factors affecting project bundling and their impacts on transportation projects (including but not limited to bridge projects). The current practices of project bundling were identified through the review of the literature from various sources. The sources include but are not limited to academic journal papers, news articles, and State DOT websites. Also, a handful of information was obtained from the Federal Highway Administration (FHWA) website.

2.2 State of the Practices

The American Association of State Highway and Transportation Officials (*7*) conducted a survey on project bundling in March 2018. The survey was responded to by 33 STAs and most of the states (85%) were found to be using project bundling for the construction of transportation projects. Bridge rehabilitation, bridge replacement, pavement resurfacing, and guardrail installation/replacement/repair projects are the major ones on which the state DOTs have been using the project bundling method. The survey results also showed that the typical size of a bundled contract ranges from $1.0M to $5.0M while the survey does not contain any information about the typical number of projects in a bundled contract. It was also observed that only 6% of the state DOTs had developed a bundling guideline and none of them had conducted any formal evaluation to measure the effectiveness of project bundling.

2.2.1 Project Bundling in Different Phases of the Project

Bundling of projects can be used in any phase of the project. A recent study showed that most of the states use project bundling in the construction phase. However, the bundling of the project is more effective if used during the environmental phase since it reduces the time required for NEPA approval (*9*). FHWA also suggested that the project bundling program should be decided in the early phase of the project to harness its full benefits. Washington State DOT (WSDOT) applied this method to multiple federal-aid projects in the planning phase and proved that it can increase the efficiency in pricing, contract administration, and constructability (*9*).

2.2.2 Project Bundling vs Project Delivery Methods

No literature has mentioned which project delivery methods should be used in bundled projects. The choice of a delivery method depends upon the project type, size, and state regulations. However, the survey by AASHTO (2018) on project bundling showed that the traditional design-bid-build (D-B-B) method is the most widely used project delivery method for bundled projects. According to the survey, 100% of the state DOT who participated in the survey have used the traditional D-B-B method while 33% of the respondents have used Design-Build (D-B) method and only 6% of them have used the Construction Manager/General Contractor at-risk method. Generally, the maintenance works that are at low risk are delivered using the D-B-B method (*10*).

The FHWA website has a wide range of information and case studies on project bundling. Following are a few examples excerpted from the website showing various state DOTs utilizing project bundling with different project delivery methods (FHWA 2019):

i. Erie County (New York) under its Preventative Maintenance Bridge Bundling Program bundled contracts for bridge maintenance and uses the D-B-B method. Similarly, under the New York State Department of Transportation (NYSDOT) Accelerated Bridge program, NYSDOT used both the D-B method and D-B-B methods. One of the bundled projects in western New York which used the D-B method covered a larger geographical area. The venture team of three contractors was formed and consequently, the project had a higher bid. To resolve this issue, NYSDOT rejected the higher bid and the project was redesigned using the D-B-B method with bundles of smaller-sized projects in closer proximity.
ii. Ohio DOT (ODOT) completed 210 bridge repairs consisting of smaller bundles of two to three bridges per contract using the design-build (D-B) delivery method. Also, ODOT has been using the design-bid-build method in their current projects. Other bridge bundling programs that have completed or ongoing projects using D-B and D-B-B methods are Missouri DOT (MoDOT) Safe and Sound Bridge Improvement Program, South Carolina (SCDOT) Bridge Bundling Program, Georgia DOT Design-Build Bridge Replacement Program, and Pennsylvania DOT (PennDOT) Local Bridge Bundling Program.
iii. Delaware DOT (DelDOT) has used the Indefinite Delivery- Indefinite Quantity (IDIQ) method in its bundled project to replace the culverts. The detailed plan for five locations was

completed by DelDOT and additional quantities were specified in the contract. The contractor was involved in the design of additional locations.

iv. Another type of delivery method used in bundled projects is the construction manager/general contractor (CM/GC). The bundled 11 major roadway projects including 13 bridge projects were successfully delivered using a CM/GC method by Osceola County (Florida) under its Roadway & Bridge Bundling Program (FHWA 2019).

2.3 Factors Affecting Project Bundling Effectiveness

The project bundling method, although effective, has several factors that need to be considered to observe a positive impact on any project (*11*). The key factors studied and proved to affect bundling include economies of scale, economies of bundle, economies of competition, function class, time of the construction, and communication with stakeholders.

2.3.1 Economies of scale

Construction companies claim to have achieved **economies of scale** when they can reduce the production or service cost as a result of performing projects on a larger scale (*12*). Project bundling helps construction companies achieve economies of scale by lowering the unit cost of the project. The size of the contract bundled, however, has a threshold after which the unit cost of a project starts increasing (*13*). During a study for bridge works, lower Maintenance of Traffic (MOT) cost ratio was achieved with a small project bundle size while the highest MOT cost ratio was found in most cases where too many bridge projects were bundled in a contract (*14*). Furthermore, larger contract sizes may discourage the smaller companies to bid, which reduces the competition, and the bidding price may increase.

2.3.2 Economies of Bundle

The effectiveness of project bundling also depends on how effectively the **bundling strategies** (***economies of bundle***) are designed (*15*). Several strategies have been studied and defined by Qiao et al. (2019) A bundling should be programmed in such a way that similar ***project types*** are included in a contract. According to the study by Qiao et al. (2019), the roadway projects yielded smaller cost savings when dissimilar project types were bundled together. The bundling policy should also consider the ***spatial proximity*** of the project. Bundling projects in the same corridor

can lead to lower project costs compared to bundling projects at different locations. This statement proved to be true for the bridge projects, small structures, and miscellaneous works (*14*). Miralinaghi et al. (*16*), in their study, also concluded that the bundled contracts that are further apart can have an adverse impact on travel time. This can cause public inconvenience too.

2.3.3 Economies of Competition

The benefit of project bundling, such as cost savings, would be greater if the market competition is higher, meaning more bidders for one project. The construction companies were said to have achieved the economies of competition if they are able to lower the bid price by increasing the market competition among a larger number of bidders (*14*). It is of great importance to any stakeholder or agency to identify the appropriate project size that is feasible enough to attract a larger number of bidders to increase the competition in the market so that the project cost can be reduced significantly. This can achieve not only the economy of competition but also an economy of scale (*4; 17*). Xiong et al. (2017) suggested that the best contract size for any bridge project that could help any agency enjoy the economies of scale and the economies of competition was about 20,000 square feet of deck area; and for pavement contracts, the contract size was evaluated to be between 10 and 20 lane miles.

2.3.4 Functional Class

Studies have also been carried out to examine the impact of bundling projects by functional class. The Maintenance of Traffic Cost (MOT) was found to be greatly impacted by factors such as road functional class, i.e. interstate versus non-interstate and urban vs. rural road projects (*14*). According to the study by Qiao et al. (2019), the MOT costs were found to be higher on the projects on interstate highways compared to those on non-interstates for road and bridge works. Similarly, the MOT costs were observed to be higher in urban projects compared to rural projects for bridge and miscellaneous works (such as sidewalks and curb ramps).

2.3.5 Communication with stakeholders

It is very important for an agency to regularly communicate with the stakeholders of the bundled project for its effectiveness. Communication must be made regularly both during the early process of project bundling and the execution of the bundled projects. FHWA (2019) Bridge

Bundling guidebook lists internal organizations, elected officials, local industry, and the public as important stakeholders. An agency should be able to identify the key person in an organization who is an expert in the field and can make an effort for its success. The bundled projects have a larger scope and area. Therefore, for effective results, local laws and rules should be well known and communicated (*10*). It is also very critical to communicate with local industries, such as fabricators, to know their production capacity before determining the contract size in a bundle. Furthermore, public participation and support have always been a crucial factor in the success of any project (*18*).

2.3.6 Supervision Staff

Adequate levels of supervision and inspection are also very critical to the successful implementation of the project bundling as multiple sites are under construction concurrently. Construction Engineering & Inspection (CEI) consulting services could be considered an effective tool for state agencies to improve their ability in maintaining a smooth workflow during peak loads, managing the staff resources as required, controlling the quality of the project, and providing expertise as necessary (*19*). The usage of CEI services has been consistent since the study by Newman (*20*). A recent report as a part of NCHRP Project 20-68A U.S. Domestic Scan also shows that most of the states, including Alabama, California, Colorado, Florida, Georgia, Nebraska, Oregon, Virginia, and Texas, use CEI services. The average usage percentage of 50-50 was reported by most states and they mostly used this service in construction inspection to smooth out peak work demands and prevent excessive hiring and layoffs (*21*).

2.4 Advantages and Disadvantages of Bundling

Project bundling can be beneficial in many ways if all the factors mentioned above are taken into consideration carefully before its implementation. Project bundling helps accelerate the project delivery time and reduce cost by providing an opportunity to work on special projects with similar features to the contractors. The contractors can maximize their workforce and reduce traffic obstructions while working on projects that are bundled in closer geographical locations (*10*). The number of contracts to be managed will be significantly reduced providing an opportunity of reducing the administrative costs to the agency. About 85% of the STAs have

claimed that they were able to reduce the administrative costs due to project bundling (*7*). The bundled contracts can also help increase the market competition and lower the bidding price from the contractor. It is seen that about 58% of the state DOTs that participated in the survey were able to reduce the bid prices due to bundled projects (*7*).

Despite these advantages, there are a few disadvantages related to project bundling, which should be taken the necessary precaution while using it. Project bundling may discourage smaller companies that are not able to handle larger projects due to resource constraints such as equipment, personnel, cash flow, and limited bonding capacities to join the competition (*7*). Thus, the market competition might be reduced, which will ultimately affect the price of the bid during procurement. Likewise, it may also discourage new companies to participate in such kinds of contracts. Furthermore, the bundled project may occasionally decrease construction quality. For instance, in a separate procurement process, a manufacturing contractor performs its work following a design contractor's specifications. However, a contractor, if given responsibility for both design and manufacture in a bundled procurement, may not have an independent contractor to verify its end product quality (*22*).

Several STAs that responded to AASHTO's survey (2018) mentioned that the project bundling can sometimes create difficulties in tracking the fund separately. There is also a risk of political pushback from local contractors that want the projects to be unbundled to reduce competition. The management of staff at each project site will be challenging as well if the bundled projects cover a larger geographical area (*7*).

2.5 Project Bundling Success Stories

There are numerous examples of bundling of projects that are soon to be commenced, ongoing, or already completed. The projects that have been completed using this strategy would help learn more about project bundling. These projects are not limited to bridges and highway projects. Several states have started using project bundling in projects like freeway lighting maintenance, renovation of travel plazas, construction of electric vehicle charging stations, installation of natural gas fueling stations, and fiber optic network installation along the road.

2.5.1 Bridge Project Bundling

FHWA defines bridge project bundling as "A defined set (or bundle) of bridges that are planned for preservation/preventive maintenance, rehabilitation, or replacement in a timely and efficient manner through a series of bridge bundling contracts with the support of various funding options and/or partnerships that may include a program completion time frame" (*8*). FHWA recently awarded $225 million to 18 state DOTs for about 20 projects that included the rehabilitation and replacement of bridges in rural areas (*23*). The fund is required to be used in bridge projects and STAs are required to bundle at least two projects into one single contract.

A selected list of successful bridge bundling projects that occurred over the past two decades is summarized as follows (*10*):

2.5.1.1 DelDOT Culvert Replacement Bridge Bundling Program

DelDOT started this program to replace the deteriorating culverts that were not included in the bridge inventory. At first, DelDOT created small bundles of culvert replacement to save costs through economies of scale. The project was delayed due to various issues at a single location of the bundle. The issues were right of way, utilities, and more. DelDOT introduced a new method of contract called IDIQ (Indefinite Delivery/Indefinite Quantity). They prepared a detailed plan of five locations that were ready to start construction and added additional quantities for other locations to be added later as the project started. The contractor awarded could also provide input and get involved in the design process of other locations, which helped them determine right-of-way needs, utility relocations, and project schedules thus saving time. It also saved time in project delivery as additional procurement was not necessary for the location added later in the project. DelDOT later created a Design-Build (D-B) contract that included 28 different culverts under one contract. This method was even more effective as the D-B team was involved in all aspects of the project (from planning to procurement).

2.5.1.2 DelDOT Preventative Maintenance Bridge Bundling Program

DelDOT initiated an open-ended contract method to carry out their preventative maintenance issues in bridges (mostly deck sealing and bridge painting works). In such a contract, project plans were put together as a proposal with the quantities and items based on assumptions, and the project was awarded based on the lowest bid. The preventative maintenance works were

performed on a need basis. The procurement process for each bridge that requires repair would take a longer process. So, DelDOT combined all the similar bridge projects that required repair works into one contract. The open-ended contract further helped save time by minimizing the response time of the contractor.

2.5.1.3 Ohio Department of Transportation (ODOT) Bridge Partnership Program

The goal of this program was to replace local bridges, about 200 in number, that are in poor condition with a budget of $110 million. ODOT worked with the FHWA collaboratively and signed an MOU. They bundled the entire project and separated projects into smaller bundles of 2-3 bridges per contract. A Design-Build method was used. ODOT completed 210 bridges (10 more than estimated) with the original budget of $110 million within 3 years of the originally expected time.

2.5.1.4 New York (NY) Works Accelerated Bridge Program

New York State Department of Transportation (NYSDOT) bundled bridges by region. NYSDOT selected 112 deficient bridges and used both traditional D-B-B and D-B project delivery methods. NYSDOT initially procured six bridge bundles that included 64 bridges using D-B-B for Phase 1A and three bridge bundles that included 32 bridges using design-build for Phase 1B. NYSDOT estimated a 27% savings over the D-B-B delivery method. The bridges in Phase 1B were bundled together in a single contract based on their spatial proximity. This allowed D-B teams to allocate their resources effectively.

2.5.1.5 Oregon Transportation Investment Act (OTIA) III State Bridge Delivery Program

Oregon DOT has been using bridge bundling since 2003. Under OTIA III State Bridge Delivery Program by Oregon DOT repaired 122 and replaced 149 state-owned bridges. It bundled the bridge repairs into a single contract along each highway corridor. Bundling of bridge repair projects reduced the cost by allowing a contractor to achieve economies of scale in design work, purchasing materials, and mobilization of equipment and resources. The bundled project also helped traffic engineers to make better plans for traffic movement during construction.

In 2004, Oregon DOT bundled 271 bridges to be replaced or repaired into 96 projects with 2 to 3 bridges per project. The bridges in the project were along the same corridor or near one another.

Project bundling was based on location and project type. The bundling strategy was maintained to maximize the movement of traffic throughout the corridor. The bundling approach helped Oregon DOT save over $200 million from reduced delays for motorists in the work zone.

2.5.1.6 PennDOT's Pilot Program

In 2012, PennDOT started a pilot project. They bundled various bridge projects that required replacement. The bundling strategy in this project was to confine the project location proximity to one county within a 15-mile radius. The bridges were single spans between 20 and 60 ft in length and skewed less than 15 degrees. Another effective bundling strategy that PennDOT applied in this project was to have a single design for all the bridges in the bundle. They stated that the bundled projects may not yield higher savings if it contains more than 3 designs per bundle. Using this strategy, PennDOT mentioned that they had saved up to 50% on design costs and up to 15% on construction costs.

2.5.2 Project Bundling Beyond Bridges

While there have been numerous bridge projects delivered under the strategy of project bundling, the bundling practice has been implemented on various types of projects beyond bridge projects among various state DOTs. For instance, Connecticut DOT developed a single contract for the operation and maintenance of its 23 highway travel plazas in 2009 located on interstate routes I-95, I-395, and 15. Maryland and Massachusetts are other states that have bundled projects like this. The Kentucky Transportation Cabinet created a single contract to develop a 3000-mile fiber optic network along roads throughout the state and awarded a P3 contract. The first segments of the network are planned to be in operation in about two years. Pennsylvania DOT, in 2016, awarded a D-B-F-O-M (Design-Build-Finance-Operate-Maintain) contract to construct compressed natural gas (CNG) fueling station at 29 public transit agency sites. The bundled project set a goal to capitalize on the great amount of natural gas in Pennsylvania. Washington State is also planning to bundle the project for the construction of electric vehicle fast-charging stations near exits along major highways.

2.6 Summary

Project bundling can simply be defined as an effective method of contracting a transportation project that bundles at-least two projects of similar features into a single contract, helping an agency to save time as well as reduce cost and create flexibility in schedule. The project size, type, location, number of projects in a bundle, and time of construction are some of the critical factors that need to be considered for the effectiveness of project bundling. The current state of practice for project bundling among various state DOTs was thoroughly reviewed using academic journal papers, recent surveys, and case studies. The major pros and cons of the project bundling were also observed through a recent survey by (*7*) and various case studies on successful bridge project bundling. For instance, Ohio DOT initiated a three-year program to replace its 200 local bridges in poor condition using the project bundling method and was successful to complete 210 bridges in the same timespan with less cost (FHWA).

The literature reveals that there are numerous benefits associated with project bundling. However, it was observed that agencies have been using project bundling mostly on bridge projects such as bridge repair, rehabilitation, maintenance, or new construction (*7*). A significant number of case studies are published (FHWA 2018) regarding project bundling on bridge projects while only a handful of studies have been carried out on roadway construction project bundling. The knowledge gained from the literature review about project bundling will be useful for conducting this research to explore the best practice of project bundling for various construction projects through a survey and case studies of State Transportation Agencies. Project bundling, other than bridges, may possess distinctive characteristics that need to be explored through this study.

CHAPTER 3: STATE OF THE PRACTICE SURVEY

3.1 Introduction

Project Bundling is a contract procurement strategy that is being widely used in bridge and highway projects. According to the Federal Highway Administration (FHWA) *EDC-5, Resource Guide*, project bundling is a process where multiple rehabilitation, repair, replacement, or preservation projects are combined to form a single larger contract.

The project bundling method has been effectively put into practice in various transportation projects by many STAs (*7*). The primary purpose of this survey was to collect the information about the current state of the practice and perception about project bundling among STA representatives as well as the encountered challenges during implementation and the barriers to adoption (if some agencies are not using it). The survey questionnaire included both closed-ended structured and open-ended semi-structured questions.

The initial draft questionnaire was prepared through an extensive literature review and then reviewed by experts with extensive project bundling experience from the FHWA Office of Infrastructure and FHWA Resource Center. The questionnaire was then revised based on their feedback. After multiple revisions, the survey questions were compiled in Qualtrics (an online survey platform) and the survey link was distributed through emails to all the members of the AASHTO Committee on Construction (COC) and Contract Administration (CA) Section including representatives from all 50 STAs. s

This report covers a wide range of survey responses received from 35 different STAs, a summary of key findings drawn from the survey analysis, and detailed findings based on a statistical analysis of the survey data.

3.2 Summary of Key Findings

This section provides a summary of major findings from the survey analysis. The survey was conducted from July 22, 2020, to October 20, 2020. A total of 35 valid responses were received from different STAs (Figure 1). The overall response rate was 70.0%. The survey respondents consisted of state construction engineers, contract engineers, construction oversight chiefs,

program managers, directors, division chiefs, area engineers, administrators, specification engineers, and contract administration engineers. The major findings that were found from the survey are:

i. The project bundling method is being used most widely on bridge projects. Major percentages of STAs have also been using the bundling method in roadway and safety projects.

ii. The majority of the STAs reported that the differences in the project bundling practice lie mainly in

   - Scope,
   - Geographic distribution
   - Design, and
   - Frequency of the bundling projects.

iii. The bundled interstates and high-volume roadway projects are typically in the same corridor whereas the bridge bundles can be expanded to a larger geographical area.

iv. The majority of the STAs assess the suitability of projects for project bundling in early phases, such as planning, programming, and design.

v. The majority of the STAs have been implementing the project bundling during the programming and design phases.

vi. The number of factors that are considered during the bundling increases with the experience of bundling the projects. The major factors that are considered during bundling by STAs are:

   - Work Type
   - Project Type
   - Spatial Proximity

   In addition to the above-mentioned factors, the STAs that have a high level of experience with bundling also consider Project Risk as an important factor during bundling.

vii. The project delivery methods that are most frequently used by STAs during bundling are:

   - Design-Bid-Build (D-B-B), and
   - Design-Build (D-B)

- Some STAs reported that they are limited only to the D-B-B method per state statutes and regulations.

viii. The majority of the STAs perceive that there is no difference in the associated risks between bundled and non-bundled projects. However, some of the risks that are involved in bundled projects are:
- Risk of encountering delays in design and construction authorization for one component of the project in a bundle while other components are ready.
- Risk of complexity that potentially compounds the impacts, such as delaying schedule and increasing cost of repetition in multiple projects bundled.

ix. STAs that experienced the above-mentioned risks in bundling mitigate them by
- Assessing the needs of the projects that are in a bundle before the bundle is formed,
- Assessment of ROW, utility relocation, environmental permits, traffic detours, and construction staging.

It was also found that bundling eliminates the risks associated with work coordination between two separate contractors.

x. The majority of the STAs have not quantified the impact of project bundling. However, some STAs are in the process of collecting adequate data as they continue practicing bundling so that they can quantify.

xi. The major advantages of the project bundling that the majority of the STAs agreed on were:
- Bundling reduces the cost of individual projects in a bundle,
- Bundling reduces agency administrative costs, and
- Bundling affords contractors the flexibility in scheduling an individual project around other projects.

xii. Project Bundling was also found to have a major impact on
- Cost, and
- Time of the project

xiii. The major concern that most of the STAs had during bundling was that the bundled projects may eliminate the competition from smaller contractors. Some STAs were also concerned over political pushback from smaller contractors. While some STAs

stated that the challenges faced during bundling largely depend on the method of procurement.

xiv. Contractors were generally found to favor the bundling method if the bundled contracts were considered effectively within the geographical area, with similar work type, time setting, and reasonable size.

3.3 Detailed Findings

This section covers the detailed findings of the survey as the result of statistical analysis of the survey data collected. The survey data collected from Qualtrics can be found in the Appendix of the report.

3.3.1 Demographics of Participants

The survey was conducted from July 22, 2020, to October 20, 2020. A total of **35** valid responses were received from different STAs (Figure 1). The overall response rate was 70.0%. The survey respondents consisted of state construction engineers, contract engineers, construction oversight chiefs, program managers, directors, division chiefs, area engineers, administrators, specification engineers, and contract administration engineers.

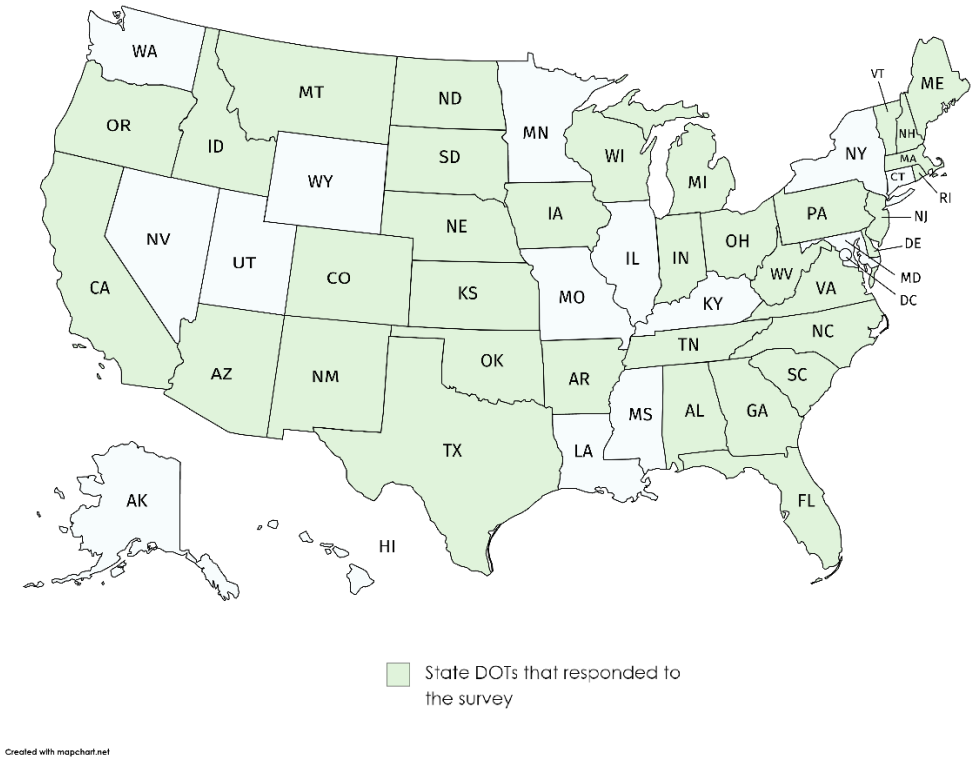

Figure 1. Map Highlighting State Transportation Agencies (STAs) Responded to the Survey

Thirty-four out of the total of 35 respondents reported that their agency had used project bundling and gained a certain level of experience with this method and only one respondent was from the STA that had never used the bundling technique. The major barrier to the adoption of bundling was the political pushback from local contractors. The participant stated that the major reason behind it was to provide opportunities to local contractors. The participant also mentioned that bundling can increase work scope, which might be too large for local contractors to participate and remain competitive.

3.3.2 Level of Experience with Project Bundling

The survey revealed that almost 70.6% of the STAs have been using the project bundling method but they have not developed a standardized process yet (Figure 2). However, the result showed an improvement in the utilization of this alternative contracting method among many STAs since almost 17.6% of STAs are in the process of standardizing the bundling strategies and 8.8% have already standardized the process as compared to the result of the AASHTO COC CA section survey regarding bundling (*7*) which had revealed that about 94% of the STAs had not

developed any bundling guidance or guidelines at that time.

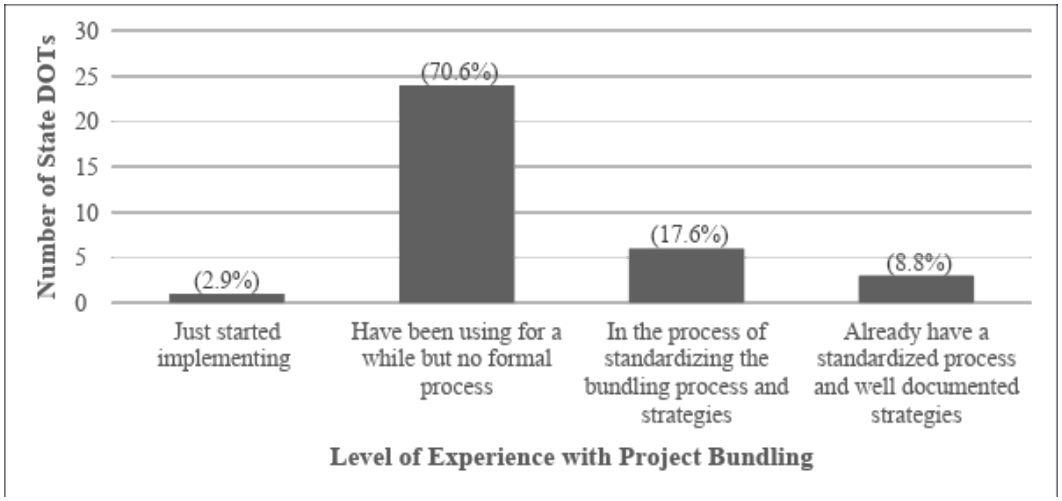

Figure 2. State Transportation Agencies' Level of Experience in Project Bundling

Note: Numbers in the parenthesis indicate the relative frequency in percentage.

3.3.3 Project Bundling by Type of Projects

The survey revealed that the project bundling method was being used more frequently by STAs (94.1%) on bridge projects, such as bridge preservation, rehabilitation, and replacement projects (Figure 3), which aligns with the findings from the literature review (*7*). Approximately 70.6% of the STAs have been using the bundling method for non-bridge projects, such as roadway projects, traffic operations, and safety projects. Also, none of the agencies have used bundling for building facility projects, such as building rehabilitation and repair, rest area construction, etc. Based on the survey responses, the major reason behind the utilization of project bundling being less in non-bridge projects was the restrictions imposed on bundling non-bridge projects. For example, one STA representative responded that, for roadway projects, all the projects needed to be in the same corridor in order to be bundled while bridge projects did not have such requirements. Therefore, a wider geographical area could be covered by bridge bundling projects and bridge bundles were easier to set up.

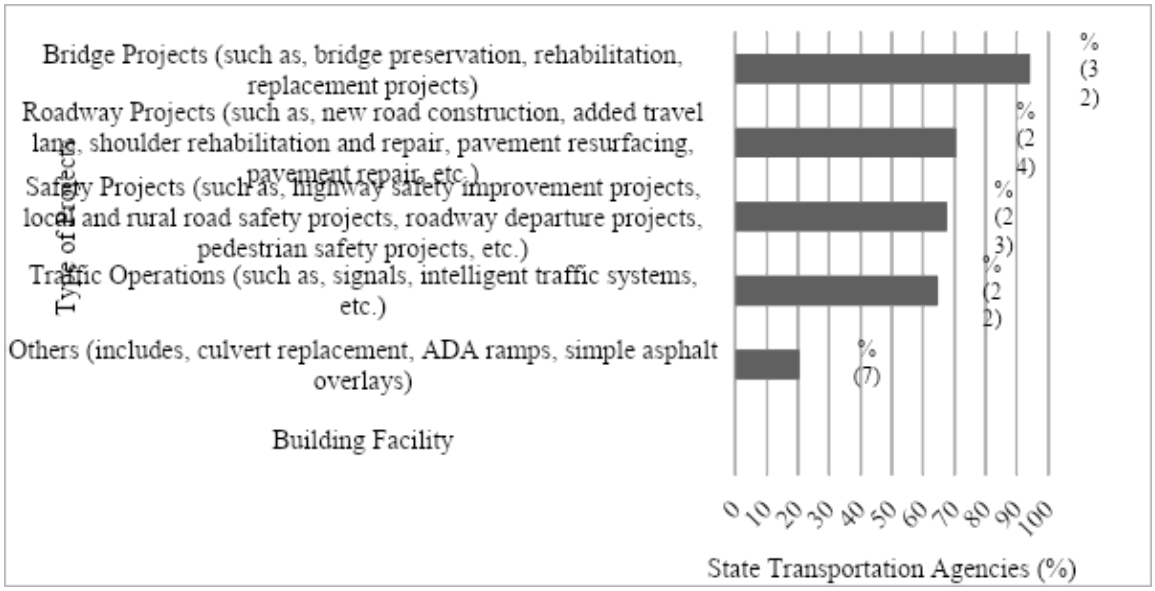

Figure 3. The Frequency of Project Bundling Use per Project Type among STAs

Note: the numbers in the parenthesis indicate the frequency in the whole number

Almost 3 quarters of the respondents reported that there were no observed differences in the practice of bundling bridge projects vs. bundling non-bridge projects (Figure 4). Among the 26.5% that reported the difference, the differences in practices lie in the scope, geographic distribution, design, and frequency of the bundling projects. STAs bundled roadway projects that are often on interstates and high-volume roads are in the same corridor whereas bridge bundles can be expanded to a larger geographical area.

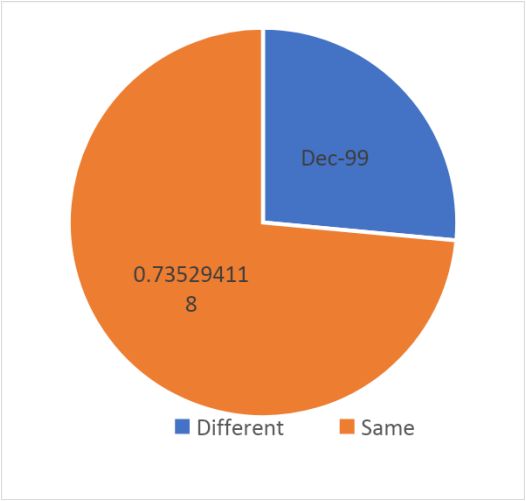

Figure 4. Reported Bundling Practice Differences Between Bridge vs. Non-Bridge Projects.

3.3.4 Assessment of the Project

As mentioned in the literature review, FHWA suggests that the benefits of the project bundling can be maximized if it is used in the early phases of the project (*24*). The survey showed that the STAs have been following the practice suggested by FHWA. Figure 5 shows that about 70.6% of the STAs practice the bundling method early during the design phase, and 52.9% during programming. However, slightly less than 1/3 (32.4%) STAs use the bundling practice as early as in the planning phase.

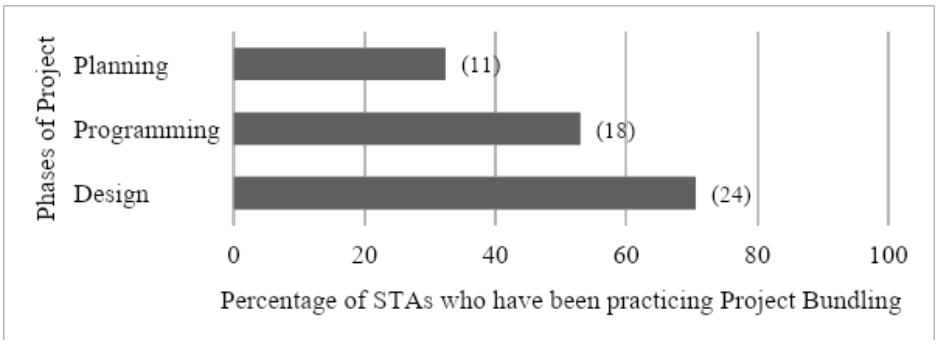

Figure 5. Percentage of STAs using Bundling Practices per Project Phase

Note: the numbers in the parenthesis indicate the frequency in the whole number

Another crucial step to gain higher benefits from the bundling method is to assess the suitability of the project for bundling. The survey revealed that only about 70.6% (24 out of 34) of the STAs have assessed the project's suitability before implementing the project bundling method. Among those 24 STAs, around half of the agencies have been assessing the project's suitability during early phases (Figure 6): planning (45.8%), programming (50.0%), and design (58.3%).

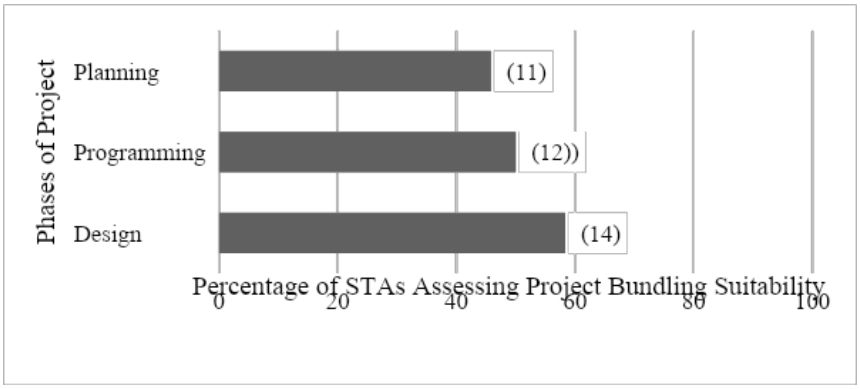

Figure 6. Percentage of STAs Assessing Project Bundling Suitability Per Project Phase

Note: the numbers in the parenthesis indicate the number of state DOTs that responded.

3.3.5 Factors Considered during Bundling

The participants were asked to record how often some factors were considered while selecting projects to bundle on a scale of 1 to 5, with 1 being never and 5 being always. The weighted average was calculated per Equation 1 and named as "selection score" in the report. The selection score tells us the average extent to which a factor is considered among the participating state agencies when including projects in a bundle. The survey found that the top three factors considered by agencies while selecting projects for bundling are *project type, work type, and spatial proximity*.

$$Selection\ Score = \frac{\sum_{i=1}^{5} in_i}{\sum_{i=1}^{5} n_i} \quad \text{.....Eq. 1}$$

Where, i = scale (1 to 5), n_i = the frequency of Scale i.

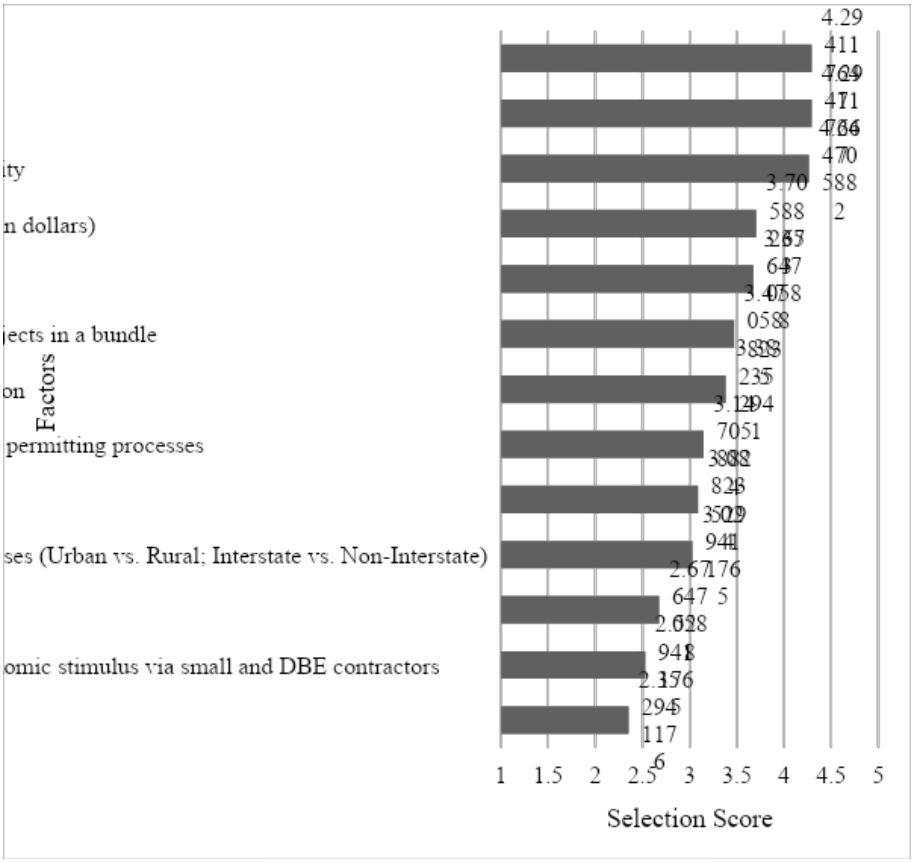

Figure 7. Factors Considered When Selecting Projects to Be Included in A Bundle (1 = never, 2 = rarely, 3 = sometimes, 4 = most of the time, and 5 = always)

In order to see if there were any statistically significant differences in the extent to which the factors were considered when selecting projects to bundle, statistical tests were performed. Since the data distribution was not normal, a non-parametric statistical test, the Friedman test, was carried out. The independent variable in the test was "factors considered", which consisted of thirteen different types: contract size (in dollars), number of projects in a bundle, project type, work type, spatial proximity, functional classes, traffic volume, design speed, letting season, environmental permitting process, ROW acquisition, project risks, and providing economic stimulus via small and DBE contractors. The dependent variable was the response. The Friedman test was performed in SPSS Statistics software. The test results (Table 1) showed that there was a statistically significant difference ($p < 0.001$, chi-square = 186.98) in the consideration of factors when selecting projects to be included in a bundle across STAs.

Table 1. Friedman Test Results

Item	**Value**
N	34
Chi-Square	186.98
Degree of Freedom (df)	12
p-value	**< 0.001**

The median values of selection score for selecting the factors were mostly 4 for all the factors except functional classes, traffic volume, design speed, letting season, environmental permitting processes, and providing economic stimulus via small and DBE contractors (Median = 3). The median value for factors, such as work type and spatial proximity, was found to be 5.

However, the Friedman test can only tell that, at least, there was one factor that was considered more often than other factors but cannot tell where the differences occurred. Post Hoc pairwise comparisons using Wilcoxon signed-rank tests were further carried out to examine where the differences occurred. The comparisons were made between each pair of factors. In total, 78 pairwise comparisons were made. A Bonferroni adjustment was used on the Wilcoxon test result to avoid Type I error. The Bonferroni adjustment was calculated by dividing the initial $p = 0.05$ value by the total number (78) of comparison tests performed. So, the new significance level was calculated to be ($\frac{0.05}{78} = 0.0006$).

Post-hoc analysis with Wilcoxon signed-rank tests conducted with a Bonferroni correction applied (Table 2) showed that the consideration of factors during project bundling varied significantly as 31 pairs out of 78 pairwise comparisons showed a statistical significance at the level of $p < 0.0006$. Table 2 includes the Z score and p-values of the pairwise comparison that were computed for the factors in the row when compared with the factor in the columns. For instance, there was no statistically significant difference in consideration of the contract size (in dollars) vs. the number of projects in a bundle among STAs ($Z = -1.363$, p-value = 0.173). However, there was a statistically significant difference in consideration of the factor contract size (in dollars) vs. traffic volume while STAs bundling projects ($Z = -3.89$, $p < 0.0006$). Similar interpretations of the result can be made for other factors in Table 2 as well.

Table 2. The Result of Wilcoxon Signed Rank Test Subject to the Bonferroni Adjustment

Factor	Results	A	B	C	D	E	F	G	H	I	J	K	L	M
A	**Z =**		-1.363	-3.262	-2.966	-2.768	-3.076	-3.89*	-4.269*	-2.887	-2.629	-1.22	-0.119	-4.383*
	***p* =**		*0.173*	*0.001*	*0.003*	*0.006*	*0.002*	*< 0.0006**	*< 0.0006**	*0.004*	*0.009*	*0.222*	*0.905*	*< 0.0006**
B	**Z =**			-3.716*	-3.785*	-3.64	-2.261	-3.257	-4.101*	-1.644	-1.641	-0.319	-1.428	-3.38
	***p* =**			*< 0.0006**	*<0.0006**	*<0.0006**	*0.024*	*0.001*	*<0.0006**	*0.100*	*0.101*	*0.749*	*0.153*	*0.001*
C	**Z =**				-0.073	-0.322	-4.748*	-4.68*	-4.835*	-4.286*	-4.387*	-3.448	-2.959	-4.946*
	***p* =**				*0.942*	*0.748*	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*0.001*	*0.003*	*< 0.0006**
D	**Z =**					-0.302	-4.744*	-4.78*	-4.832*	-4.388*	-4.476*	-3.548*	-3.136	-4.767*
	***p* =**					*0.763*	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*0.002*	*< 0.0006**
E	**Z =**						-4.566*	-4.618*	-4.688*	-4.227*	-4.202*	-3.17	-2.804	-4.777*
	***p* =**						*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*< 0.0006**	*0.002*	*0.005*	*< 0.0006**
F	**Z =**							-2.814	-3.906*	-0.36	-0.667	-1.826	-3.157	-2.345
	***p* =**							*0.005*	*< 0.0006**	*0.719*	*0.505*	*0.068*	*0.002*	*0.019*
G	**Z =**								-2.81	-1.839	-2.285	-2.896	-3.7*	-0.564
	***p* =**								*0.005*	*0.066*	*0.022*	*0.004*	*< 0.0006**	*0.572*
H	**Z =**									-2.866	-3.47	-3.747*	-4.284*	-0.847
	***p* =**									*0.004*	*0.001*	*< 0.0006**	*< 0.0006**	*0.397*
I	**Z =**										-0.2	-1.246	-2.52	-2.432
	p =										*0.842*	*0.213*	*0.012*	*0.015*
J	**Z =**											-1.498	-3.218	-2.506
	***p* =**											*0.134*	*0.001*	*0.012*
K	**Z =**												-2.233	-3.233
	***p* =**												*0.026*	*0.001*
L	**Z =**													-4.376*
	***p* =**													*< 0.0006**

Note: The Z scores and p-values of the pairwise comparison were computed for the factor in the row when compared with the factor in the column.

A – Contract size (in dollars)
B – Number of projects in a bundle
C – Project type
D – Work type
E – Spatial proximity
F – Functional classes (Urban vs. Rural; Interstate vs. Non-Interstate)
G – Traffic volume
H – Design speed
I – Letting season
J – Environmental permitting processes
K – ROW acquisition
L – Project risks
M – Providing economic stimulus via. Small and DBE contractors

The selection score was also compared between the two groups of STAs categorized based on their level of experience with bundling:

- STAs with a lower level of experience with project bundling, which include STAs that have been using bundling but no formal process (n= 25), and

- STAs with a higher level of experience with project bundling (n = 9), which include STAs that are in the process of standardizing the process as well as STAs that already have a standardized process and well-documented strategies.

The result (Table 3) showed that

- STAs that have a lower level of experience with project bundling most frequently consider project type, work type, and spatial proximity as important factors when selecting projects to be included in a bundle.
- STAs that have a higher level of experience with project bundling also consider the project risk as an essential factor in addition to the project type, spatial proximity, and work type to select projects to be included in a bundle.

Table 3. The Average and Median Selection Score of the Factors Considered during bundling by STAs Per Level of Experience (1 = never, 2 = rarely, 3 = sometimes, 4 = most of the time, and 5 = always).

Factor	**Descriptive Statistics**	**Low Experience Level (N=25)**	**High Experience Level (N = 9)**
Contract size (in dollars)	Average = Median =	3.8 4.0	3.6 4.0
Number of projects in a bundle	Average = Median =	3.4 4.0	3.7 3.0
Project Type	Average = Median =	4.3 4.0	4.3 4.0
Work Type	Average = Median =	4.2 4.0	4.7 5.0
Spatial Proximity	Average = Median =	4.1 4.0	4.7 5.0
Functional Classes (Urban vs. Rural; Interstate vs. Non-Interstate)	Average = Median =	3.0 3.0	3.1 3.0
Traffic Volume	Average = Median =	2.7 3.0	2.7 3.0
Design Speed	Average = Median =	2.3 2.0	2.4 2.0

Factor	Descriptive Statistics	Low Experience Level (N=25)	High Experience Level (N = 9)
Letting Season	Average = Median =	3.1 3.0	3.1 3.0
Environmental Permitting Processes	Average = Median =	3.0 3.0	3.6 3.0
ROW Acquisition	Average = Median =	3.3 3.0	3.7 4.0
Project Risks	Average = Median =	3.5 4.0	4.2 4.0
Providing Economic Stimulus via. Small and DBE Contractors	Average = Median =	2.6 3.0	2.2 2.0

A non-parametric, Kruskal Wallis test, was further performed to test if the consideration of the factors used while bundling projects were statistically significantly different among those two groups of STAs based on their level of experience with bundling.

Table 4. Kruskal-Wallis Test Result for Factors Considered during Project Bundling between Low- and High-level Experience Groups

Factors considered during project bundling.	Kruskal-Wallis H	*df*	*p-value*
Contract size (in dollars)	0.380	1	0.538
Number of projects in a bundle	0.106	1	0.745
Project Type	0.007	1	0.932
Work Type	2.008	1	0.156
Spatial Proximity	2.538	1	0.111
Functional Classes (Urban vs. Rural; Interstate vs. Non-Interstate)	0.192	1	0.661
Traffic Volume	0.015	1	0.903
Design Speed	0.004	1	0.951
Letting Season	0.052	1	0.820
Environmental Permitting Processes	1.161	1	0.281
ROW Acquisition	0.793	1	0.373
Project Risks	3.144	1	0.076
Providing Economic Stimulus via. Small and DBE Contractors	0.863	1	0.353

Note: The grouping variables were the STAs based on their level of experience with bundling.

The Kruskal Wallis test result (Table 4) showed that there were no statistically significant differences in consideration of the factors between the different groups of STAs based on their level of experience with bundling ($p > 0.05$).

3.3.6 Total Score for Factors Considered during Bundling vs. Level of Experience

Further analysis was performed to identify the extent to which the list of factors each STA considers during project bundling. There were 13 factors included in the survey each with the highest score of 5 and lowest of 1 so the highest total score being (13 × 5) = 65 and the lowest total score being (13 × 1) 13 for each agency. The summation of scores provided by STAs for all the factors listed in the survey was calculated and it was interpreted that the higher the total score provided, the larger extent to which the list of factors considered by that STAs during bundling.

Table 5. The Statistics of the Total Score for Factors Considered during Bundling between Low- and High-level Experience Groups

STAs based on the level of experience with bundling	Average Total Score	Standard Deviation
Low Level	43.200	8.784
High Level	45.889	9.212

The comparison of the total score provided was made between STAs grouped according to their level of experience with project bundling (Table 5). STAs that have a lower level of experience with project bundling provided an average total score of 43.2, and the STAs that have a higher level of experience with project bundling provided an average total score of 45.9. Thus, it was observed that a higher number of factors were frequently considered during project bundling by the STAs that have a higher level of experience with the project bundling than their counterparts.

To test if the observed differences were statistically significant, additional statistical tests were performed. Since there were two groups of STAs based on the level of their experience with bundling, unequal sample sizes, and the variables were not normal, a non-parametric, Kruskal Wallis test, was performed.

Table 6. Kruskal-Wallis Test Result for Total Score for Factors Considered during Bundling between Low- and High-level Experience Groups

Item	Value
Kruskal-Wallis H	0.495
Df	1
p	0.482

The test result (Table 6) showed that the total selection score of all the factors considered during bundling between low- and high-level bunding experience groups was not statistically significantly different ($p = 0.482$).

3.3.7 Project Delivery Methods

The survey found that STAs most frequently use Design-Bid-Build (D-B-B) and Design-Build (D-B) delivery methods for bundled contracts. Figure 8 shows that about 94.1% of STAs have used the D-B-B method and 41.2% have used the D-B method. The response also shows that a few other alternative delivery methods were used in bundled contracts, such as Indefinite Delivery and Indefinite Quantity (ID/IQ), Construction Manager/General Contractor (CM/GC), and Public-Private Partnership. The higher use of the D-B-B method was found because most of the STAs were limited only to the D-B-B method per state statutes and regulations.

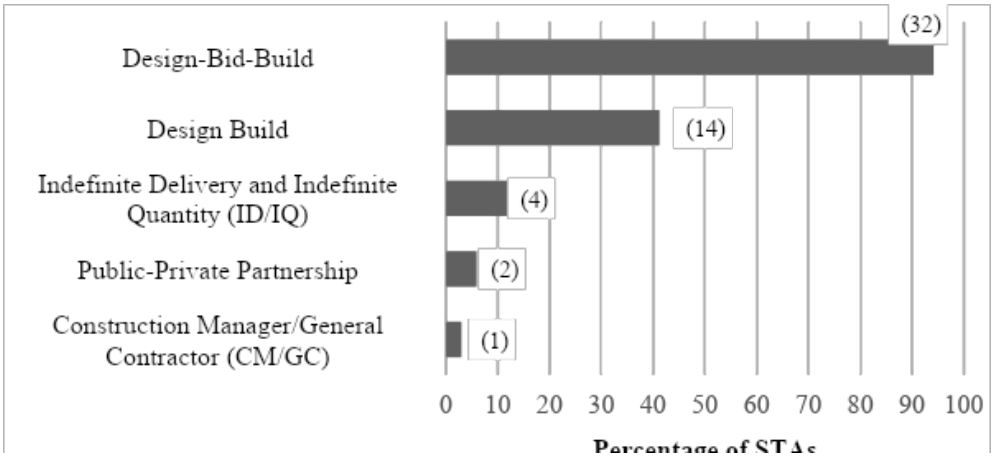

Figure 8. Project Delivery Methods Used by STAs for Bundled Contracts.

Note: the numbers in parentheses indicate the frequency in the whole number.

3.3.8 Risks Associated with Bundling

The survey revealed that 25 (73.5%) out of the 34 STA representatives that have been using the bundling method indicated that the risk levels in the bundled projects were the same as if individual projects would be contracted separately (Figure 9).

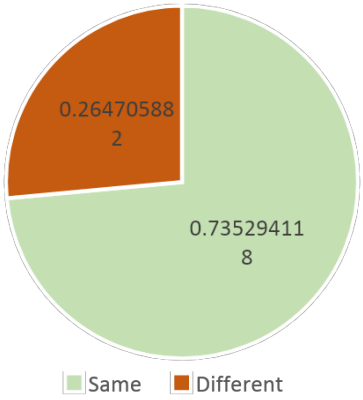

Figure 9. Survey responses of Perceived Risk Difference between Bundle and Non-bundle Options

Some of the risks involved in bundled projects shared by the participants were as follows:

- There is a risk of encountering delays in design and construction authorization for one component of the project in a bundle while other components are ready.
- Multiple projects together can present the risk of complexity and potentially compound the impacts, such as delaying schedule and increasing the cost of repetition.

Based on the survey responses by the participants, these risks, however, can be managed by assessing the needs of the projects that are in a bundle before the bundle is formed. The assessment can be of ROW, utility relocation, environmental permits, traffic detours, and construction staging. The bundling method is also found to eliminate the risks associated with work coordination between two separate contractors.

3.3.9 Impact of Bundling

The project bundling method is still relatively new to many agencies and most of the state DOTs have been using this method with no formal processes and standard documents (Figure 2). It was observed that about 82.0% of the STAs that participated in the survey have never quantified the impact of the project bundling compared to traditional contracting strategies (Figure 10). A couple of cited reasons for not quantifying the impact among the participants were that the bundled contracts were relatively small and that most of the STAss thought the comparison would not provide any useful information beyond what is not already known. While some STAs mentioned that they are in the process of collecting adequate data as they continue practicing project bundling so that correct quantification could be performed in the future.

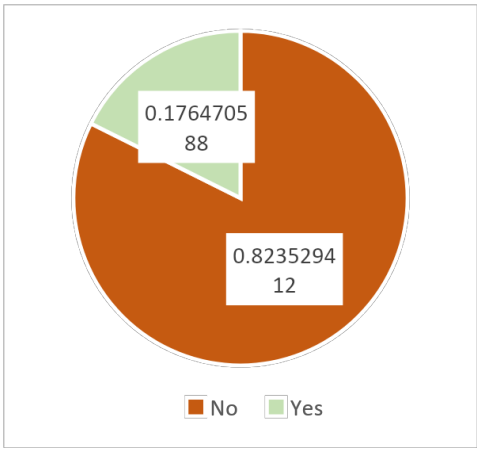

Figure 10. Percentage of the STAs That Have Ever Quantified the Impact of Project Bundling

The participants were asked to record their perceptions of the benefits and challenges of project bundling on a scale of 1 to 5, with 1 being "strongly disagree" and 5 being "strongly agree". The weighted average was calculated using Equation 2 similar to the selection score mentioned before and named as the "impact factor" in the report. The impact factor tells us the average perception of the positive and negative impacts of the bundling method.

$$Impact\ Factor = \frac{\sum_{i=1}^{5} in_i}{\sum_{i=1}^{5} n_i} \quad \ldots \text{Eq. 2}$$

Where, i = scale (1 to 5), n_i = the frequency of Scale i.

3.3.10 Advantages of Project Bundling

In the survey, a significant number of STAs agreed that the reduction of the cost of the individual projects in a bundle, reduction of agency administrative costs, flexibility to the contractor in scheduling an individual project around other projects, and reduction of project delivery time per project were the most significant benefits of the project bundling (impact factor > 3.5). STAs were neutral about other advantages of the project bundling, such as improving the project quality, achieving economies of competition, and reducing change orders (Figure 11).

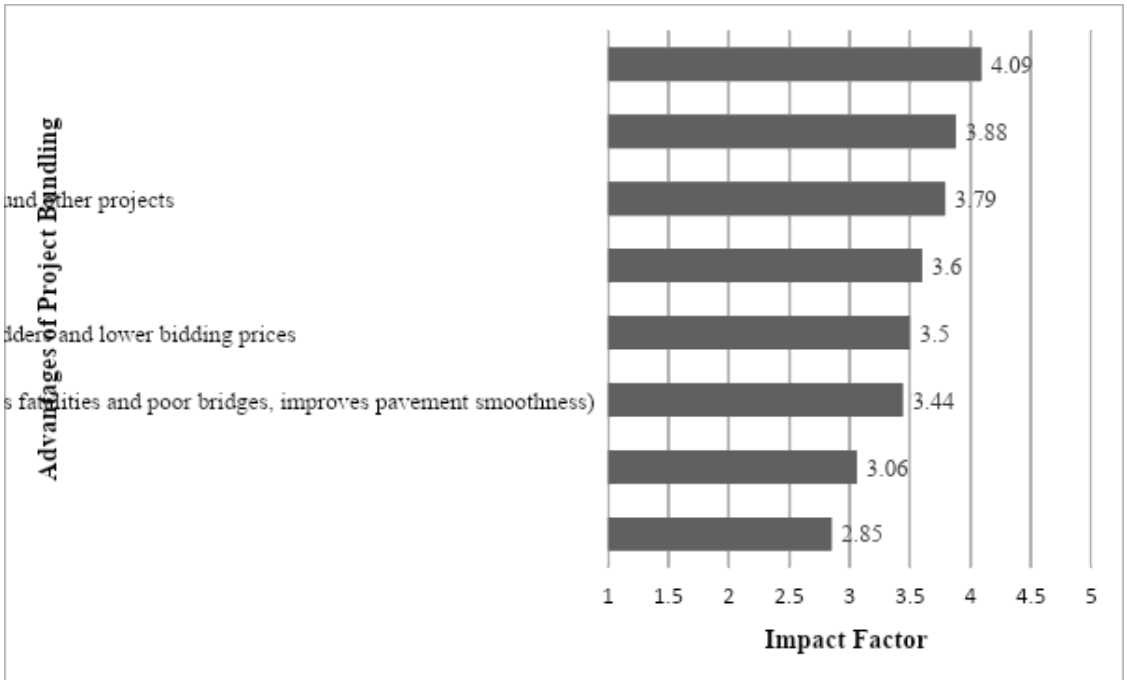

Figure 11. The Impact Factor of the Advantages of Project Bundling (1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, and 5 = strongly agree)

In addition, the STAs also mentioned that the flexibility in scheduling individual projects around other projects provided by bundled contracts has helped STAs provide convenience to the public by reducing traffic interruption.

A non-parametric statistical test, the Friedman test, was carried out to see if there were any statistically significant differences in perceived benefits of bundling among different STAs. The independent variable in the test was "advantages of bundling", which consisted of eight different benefits as shown in Figure 11. The Friedman test was carried out in SPSS Statistics software. The test results (Table 7) showed that there was a statistically significant difference ($p<0.001$, chi-square = 70.1) in the perceived benefits of bundling among all STAs.

Table 7. Friedman Test Result for Advantages of Bundling

Item	**Value**
N	34
Chi-Square	70.1
Degree of Freedom (df)	7
p-value	**< 0.001**

Post Hoc pairwise comparisons using the Wilcoxon signed-rank test were further carried out to examine where the differences occurred between different benefits listed in the survey. The

comparisons were made between each pair of factors. In total, 28 pairwise comparisons were made (Table 8). A Bonferroni adjustment was used on the result obtained from the Wilcoxon test since multiple comparisons were made to avoid Type I errors. The Bonferroni adjustment was calculated by dividing the initial $p = 0.05$ value by the total number (28) of comparison tests performed. So, the new significance level was calculated to be ($0.05/28 = 0.002$).

The results of the post-hoc analysis with the Wilcoxon signed-rank test conducted with a Bonferroni correction, resulting in a significance level set at $p = 0.002$, are shown in Table 8. It was observed that 11 pairs out of 28 pairwise comparisons computed of the perceived benefits of project bundling were statistically significantly different ($p < 0.002$). The Z score and p-values shown in Table 7 are the results computed for the perceived benefits in the row when compared with the factor in the column. For example, there was no statistically significant difference in the perception of STAs between the benefits like reduction of agency administrative costs and reduction of cost of the individual projects in a bundle ($Z = -1.442$, $p = 0.149$). However, the perception of STAs between the benefits of reduction of agency administrative costs and improvement of the project quality is statistically significantly different ($Z = -3.344$, $p = 0.001$). The results shown in table 8 can be interpreted similarly for other pairwise comparisons computed as well.

Table 8. Post-hoc Analysis using Wilcoxon Signed Rank Test Result for Perceived Bundling Benefits

vs.	Reduces agency administrative costs	Reduces the cost of the individual projects in a bundle	Reduces project delivery time per project	Helps achieve economies of competition, meaning higher number of bidders and lower bidding prices	Improves the project quality	Reduces change orders	Affords the contractor flexibility in scheduling an individual project around other project.	Helps achieve asset management system performance goals (e.g. reduces fatalities and poor bridges, improves pavement smoothness)
A		Z = -1.442 p = 0.149	Z = -1.196 p = 0.232	Z = -1.588 p = 0.112	Z = -3.344* p = 0.001*	Z = -3.464* p = 0.001*	Z = -0.429 p = 0.668	Z = -2.080 p = 0.037
B			Z = -2.531 p = 0.011	Z = -3.442 p = 0.001	Z = -4.129* p < 0.001*	Z = -4.524* p < 0.001*	Z = -2.097 p = 0.036	Z = -3.238* p = 0.001*
C				Z = -0.698 p = 0.485	Z = -3.662* p < 0.001*	Z = -4.291* p < 0.001*	Z = -1.262 p = 0.207	Z = -1.032 p = 0.302
D					Z = -2.438 p = 0.015	Z = -3.378* p = 0.001*	Z = -1.281 p = 0.200	Z = -0.624 p = 0.533
E						Z = -1.748 p = 0.080	Z = -3.731* p < 0.001*	Z = -2.446 p = 0.014
F							Z = -3.852* p < 0.001*	Z = -3.25* p = 0.001*
G								Z = -2.034 p = 0.042
H								

Note:
The Z score and p-values of the pairwise comparison were computed for the factor in the row when compared with the factor in the column.
The pairwise comparisons that are statistically significantly different are highlighted with '' in the table.*

A - Reduces agency administrative costs
B - Reduces the cost of the individual projects in a bundle
C - Reduces project delivery time per project
D - Helps achieve economies of competition, meaning higher number of bidders and lower bidding prices
E - Improves the project quality.
F - Reduces change orders
G - Affords the contractor flexibility in scheduling an individual project around other project.
H - Helps achieve asset management system performance goals (e.g. reduces fatalities and poor bridges, improves pavement smoothness)

The impact factors were also compared between the two groups of STAs according to their level of experience with bundling. The result, on contrary, showed that the higher the level of experience with bundling, the lesser the perceived benefits towards project bundling (Figure 12).

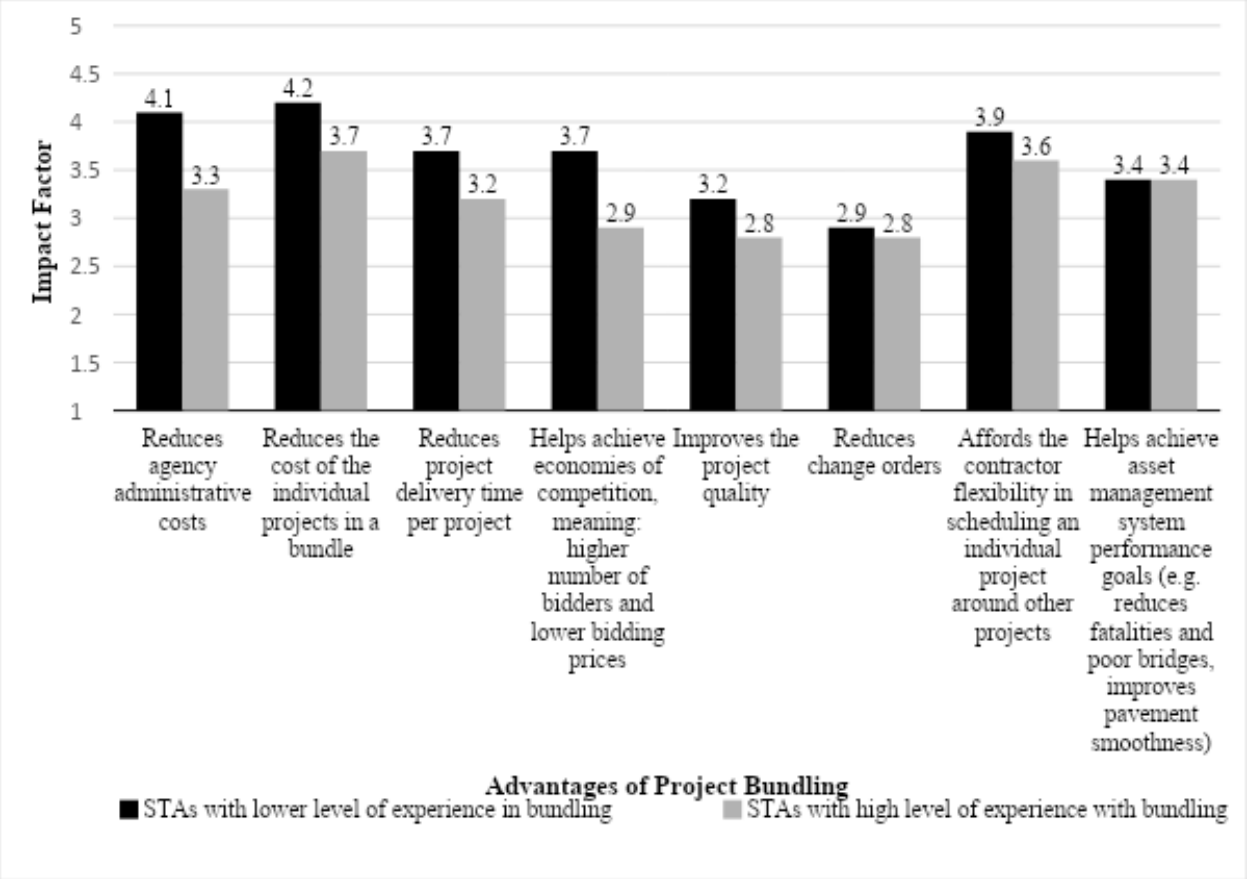

Figure 12. The Impact Factor of the Advantages of Project Bundling Per Experience Level (1 = strongly disagree, 2 = somewhat disagree, 3 =neither disagree nor agree, 4 = somewhat agree, and 5 = strongly agree).

Further analysis using a non-parametric Kruskal-Wallis test was performed to see if the perception of various benefits of bundling differed among groups with different levels of experience in bundling (i.e. STAs with a lower level of experience with project bundling (n= 25), and STAs with a higher level of experience with project bundling (n = 9).

Table 9. Kruskal-Wallis Test on Perceived Benefits of Project Bundling among Groups of STAs with Different Levels of Experience in Bundling

Perceived Benefits of Project Bundling	Kruskal-Wallis H	df	p-value
Reduces agency administrative costs	2.734	1	0.098
Reduces the cost of the individual projects in a bundle	3.605	1	0.058
Reduces project delivery time per project	2.870	1	0.090
Helps achieve economies of competition, meaning higher number of bidders and lower bidding prices	4.893*	1*	0.027*
Improves the project quality	3.251	1	0.071
Reduces change orders	0.009	1	0.922
Affords the contractor flexibility in scheduling an individual project around other project.	0.765	1	0.382
Helps achieve asset management system performance goals (e.g. reduces fatalities and poor bridges, improves pavement smoothness)	0.002	1	0.966

The result showed that (Table 9) the perceived benefit of project bundling was statistically significantly different only towards one benefit between the two groups of STAs, i.e. bundling helps achieve economies of competition, among two groups of STAs ($p = 0.027$).

3.3.11 Perceived Percentage of Impact in Project Bundling Benefits

The survey also requested the participants to provide the perceived impact in percentage for four major benefits: times savings, cost savings, quality increase, and reduction in change orders with an impact factor of 1 to 4, 1 being no impact to 4 having 40-60% impact. The result showed that the majority of the STAs perceived that the bundling method could potentially save about 0-20% (impact factor = 1.9) of the time and cost of the project (impact factor = 2.1), while it has no impact on project quality and reduction in change orders (impact factor = 1.3).

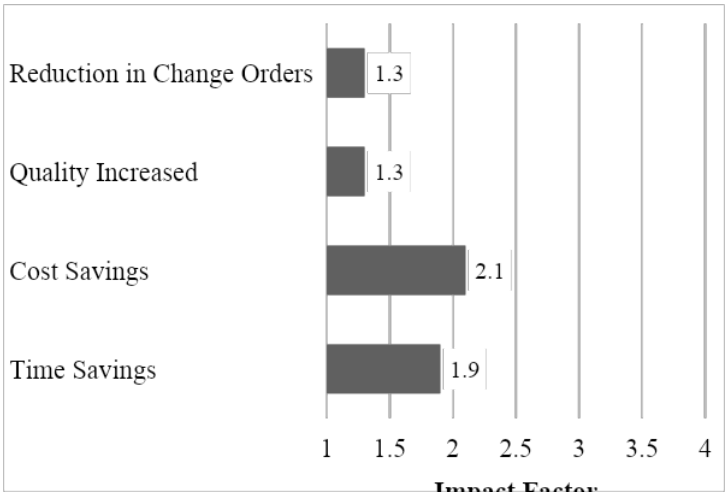

Figure 13. Perceived Impact due to Project Bundling among STAs (1 = no impact, 2 = 0 - 20%, 3 = 20 - 40%, and 4 = 40 - 60%)

A non-parametric statistical test, the Friedman test, was carried out to see if there were any statistically significant differences in the impact factor among the perceived benefits of bundling. The Friedman test was carried out in SPSS Statistics software. The test results (Table 10) showed that there was a statistically significant difference ($p < 0.001$, chi-square = 45.029) in the impact factors among all perceived benefits.

Table 10. Friedman Test Result for Perceived Impact due to Project Bundling

Item	**Value**
N	34
Chi-Square	45.029
Degree of Freedom (df)	3
p-value	**< 0.001**

Post-hoc pairwise comparisons using the Wilcoxon signed-rank test were further carried out to examine where the differences occurred between different benefits listed in the survey. The comparisons were made between each pair of factors. In total, 6 pairwise comparisons were made (Table 11). A Bonferroni adjustment was used on the result obtained from the Wilcoxon test to avoid Type I error due to multiple pairwise comparisons. The Bonferroni adjustment was calculated by dividing the initial $p = 0.05$ value by the total number (6) of comparison tests performed. So, the new significance level was calculated to be ($0.05/6 = 0.008$).

Table 11. Post Hoc Analysis of the Perceived Percentage of Impact due to Project Bundling (1 = No impact, 2 = 0-20%, 3 = 20-40%, and 4 = 40-60%)

Vs.	Cost Savings	Time Savings	Quality Increased	Reduction in Change Orders
Cost Savings		Z = -1.761 p = 0.078	Z = -4.132* p < 0.008*	Z = -3.613* p < 0.008*
Time Savings			Z = -3.788* p < 0.008*	Z = -3.629* p < 0.008*
Quality Increased				Z = 0 p = 1.0
Reduction in Change Orders				

Note:
The Z scores and p-values of the pairwise comparison were computed for the factor in the row when compared with the factor in the column.
The pairwise comparisons that are statistically significantly different are highlighted with '' in the table.*

The results of the post-hoc analysis with the Wilcoxon signed-rank test conducted with a Bonferroni correction, resulting in a significance level set at p = 0.008, are shown in Table 11. It was observed that 4 pairs out of 6 pairwise comparisons computed of the perceived percentage of savings due to project bundling were statistically significantly different (p < 0.008). The Z score and p-values shown in the table are the results computed for the perceived benefits in the row when compared with the perceived benefits in the column. For example, there was no statistically significant difference in the perception of the percentage of savings among STAs between the cost and time savings (Z = -1.761, p = 0.078). However, the perceived percentages of cost savings and quality increase due to project bundling were statistically significantly different (Z = -4.132, p < 0.008). The results shown in Table 11 can be interpreted similarly for other pairwise comparisons computed as well.

3.3.12 Perceived Percentage of Impact in Project Bundling Benefits vs. Level of Experience with Bundling

To further analyze the perceived percentage of savings among STAs in the benefit of project bundling, a comparison was made between the two groups of STAs according to their level of experience with project bundling: STAs that have a lower level of experience with bundling (n = 25), and STAs that have a higher level of experience with bundling (n = 9).

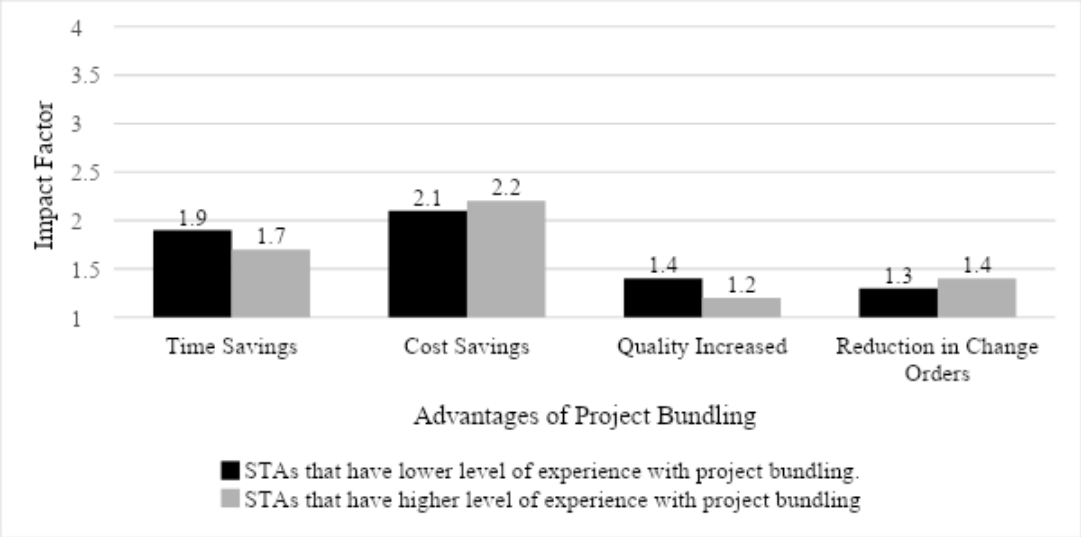

Figure 14. Perceived Percentage of Impact of Project Bundling Per Experience Group (1 = No impact, 2 = 0-20%, 3 = 20-40%, and 4 = 40-60%)

The result showed that the perception of savings due to project bundling is similar in both groups of STAs. The majority of the STAs responded that there are 0-20% savings in time and cost due to the project bundling method and no impact on the quality of the project and the change orders. A non-parametric Kruskal-Wallis test was performed to measure the differences in the perception of the percentage of savings among the two groups of STAs.

Table 12. Kruskal-Wallis Test Results for Perceived Percentage of Impact due to Project Bundling between Low- and High-level Experience Groups

Perceived Benefits of Project Bundling	Kruskal-Wallis H	df	p-value
Time Savings	1.329	1	0.249
Cost Savings	0.418	1	0.518
Quality Increased	0.348	1	0.555
Reduction in Change Orders	0.369	1	0.543

Note: Each perceived benefit was compared among grouping variables, i.e. two groups of STAs based on their experience with bundling

The result (Table 12) showed that there was no statistically significant difference in the perceived percentage of time/cost savings, quality improvement, and change order reductions due to project bundling between the low- and high-level experience groups ($p > 0.05$).

3.3.13 Concerns over Project Bundling

The survey found that a significant number of STAs had moderate concerns about the reduction of the competition from smaller contractors (mean impact factor = 2.9) while using the project bundling method (Figure 15). The bundling method may eliminate smaller contractors from participating in bidding along with larger contractors, thus, decreasing the bidding competition.

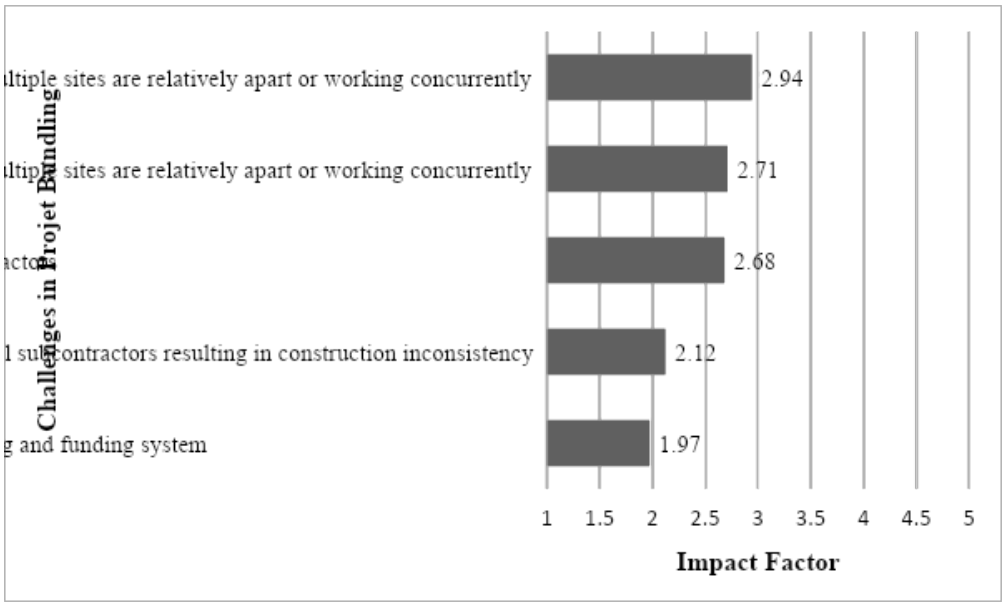

Figure 15. The Average Impact Factor of Challenges in Project Bundling for STAs (1 = not at all concerned, 2 = of a little concern, 3 = moderately concerned, 4 = concerned, and 5 = very concerned).

Friedman test was performed to observe the differences in the perceived challenges in project bundling among all STAs. The test result showed that (Table 13) the levels of concern over the challenges associated with project bundling vary statistically significantly ($p < 0.001$).

Table 13. Friedman Test Result for Perceived Challenges during Project Bundling among STAs.

Item	Value
N	34
Chi-Square	31.566
Degree of Freedom (df)	4
p-value	**< 0.001**

As mentioned before, the Friedman test only tells us that there was at least one challenge that is concerned significantly differently by STAs than other challenges, but it cannot tell where the

differences occurred. So, Post-hoc pairwise comparisons using the Wilcoxon signed-rank test were further carried out to examine where the differences occurred. The comparisons were made between each pair of challenges. In total, 10 pairwise comparisons were made. A Bonferroni adjustment was used on the result obtained from the Wilcoxon test since multiple comparisons were made to avoid Type I errors. The Bonferroni adjustment was calculated by dividing the initial p = 0.05 value by the total number (10) of comparison tests performed. So, the new significance level was calculated to be ($\frac{0.05}{10}$ = 0.005).

The results obtained from a post-hoc analysis with Wilcoxon signed-rank tests conducted with a Bonferroni correction applied are shown in Table 14. The Z score and p-values in the table indicate the result obtained from the pairwise comparison performed between the factor in the row and the factor in the column. The result showed that there were statistically significant differences among 4 pairs out of 10 pairwise comparisons computed. It can be seen that there is a significant difference ($Z = -3.240, p < 0.005$) in STAs' perception between the challenge to track the funds separately due to the accounting and funding system and the challenge to ensure adequate staffing levels at each site when multiple sites are relatively apart or working. However, there is no statistically significant difference in the perception of STAs between the challenges of tracking the funds separately due to the accounting and funding system and political pushback from local smaller contractors ($Z = -2.624, p = 0.009$). Similar interpretations can be performed from the results in Table 14.

Table 14. Post Hoc Analysis using Wilcoxon Signed Rank Test Result for Perceived Challenges during Project Bundling

Vs.	It has been a challenge to track the funds separately due to accounting and funding system	Ensuring adequate staffing levels at each site is challenging when multiple sites are relatively apart or working concurrently	Project bundling creates political push-back from local smaller contractors	Bundled projects may eliminate the competition from smaller contractors, thus decreasing bidding competition	Multiple projects in a bundle may result in the involvement of several subcontractors resulting in construction inconsistency
It has been a challenge to track the funds separately due to accounting and funding system		Z= -3.240* p = 0.001*	Z = -2.624 p = 0.009	Z = -3.617* p < 0.005*	Z = -0.730 p = 0.465
Ensuring adequate staffing levels at each site is challenging when multiple sites are relatively apart or working concurrently			Z = -0.021 p = 0.983	Z = -1.285 p = 0.199	Z = -2.683 p = 0.007
Project bundling creates political push-back from local smaller contractors				Z = -2.183 p = 0.029	Z = -2.979* p = 0.003*
Bundled projects may eliminate the competition from smaller contractors, thus decreasing bidding competition					Z = -4.460* p < 0.005*
Multiple projects in a bundle may result in the involvement of several subcontractors resulting in construction inconsistency					

Note:
The Z score and p-values of the pairwise comparison were computed for the factor in the row when compared with the factor in the column.
The pairwise comparisons that are statistically significantly different are highlighted with '' in the table.*

The comparison of the impact factor was also made among the STAs based on their level of experience with project bundling (Figure 16). The results revealed that the two groups had almost similar concerns over the challenges like tracking funds separately due to accounting and funding systems and ensuring adequate staffing levels at each site when multiple sites are relatively apart or working concurrently. However, the concerns over most of the challenges were slightly decreased with the increase in the level of experience with bundling.

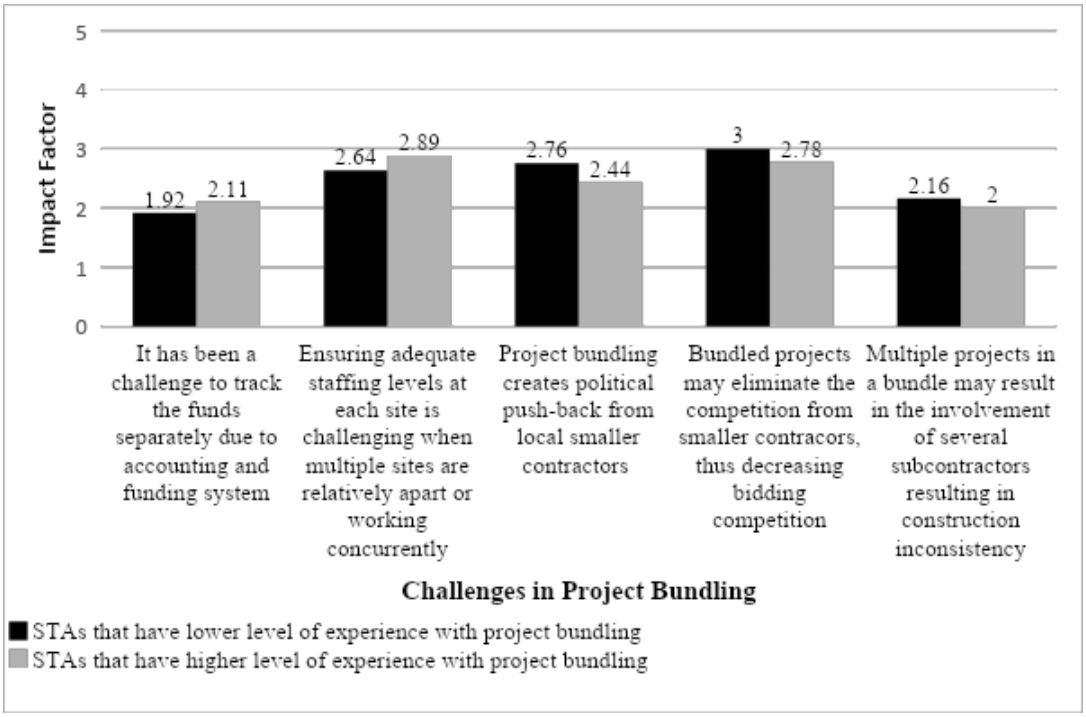

Figure 16. Challenges faced by STAs in project bundling method Per Experience Level (1 = not at all, 2 = of a little concern, 3 = moderately concerned, 4 = concerned, 5 = very concerned)

Thus, the standardized process and well-documented strategies can build STAs' confidence in using the bundling method. It was also observed that the level of challenges faced by the agencies could be reduced when the agencies using the bundling method have access to a standard process. STAs also mentioned in the survey that the challenges faced during bundling also largely depend on the method of procurement, such as the alternative contracting method versus the traditional D-B-B method. Under some alternative contractual frameworks, small contractors can partner up for larger projects, which may reduce STAs' concern over political pushback from smaller contractors as well as the concern over eliminating smaller contractors'

participation. However, when traditional D-B-B is used, they may remain the subject of concern to STAs.

A nonparametric Kruskal-Wallis test was further performed to see if the perceived challenges in the project bundling method differed based on the level of experience of STAs with bundling. The dependent variables were the challenges in project bundling and the independent variable was the STA group based on their level of experience with bundling: STAs that have a lower level of experience with project bundling (n = 25), and STAs that have a higher level of experience with project bundling (n = 9).

Table 15. Kruskal-Wallis Test results for Perceived Challenges during Project Bundling per Level of Experience with Bundling

Perceived Challenges of Project Bundling	Kruskal-Wallis H	df	p-value
It has been a challenge to track the funds separately due to accounting and funding system	0.138	1	0.711
Ensuring adequate staffing levels at each site is challenging when multiple sites are relatively apart or working concurrently	0.314	1	0.575
Project bundling creates political push-back from local smaller contractors	0.480	1	0.488
Bundled projects may eliminate the competition from smaller contractors, thus decreasing bidding competition	0.247	1	0.619
Multiple projects in a bundle may result in the involvement of several subcontractors resulting in construction inconsistency	0.316	1	0.574

Note: Each perceived challenge during project bundling was compared with a grouping variable, i.e. two groups of STAs based on their experience with bundling

The test result (Table 15) showed that there were no statistically significant differences in the perception of challenges during project bundling between the two groups of STAs based on their level of experience with bundling (p-value > 0.05).

3.3.14 Feedback from Contractors

The survey found that about 38% of the STAs practicing bundling have received feedback from contractors. The major concerns were from small to medium-sized contractors since the larger bundles may limit their ability to participate in bidding. It was also found that contractors mostly prefer D-B procurement. Also, if the bundled contracts are considered effectively within the geographical area, with similar work type, time setting, and reasonable sizes, then the contractors

are found to favor the bundling method.

3.4 Summary

The project Bundling method is a contract procurement strategy widely practiced by state transportation agencies in many bridge and non-bridge projects by combining multiple projects to form a single larger contract. The survey provides knowledge on the current practices as well as perceived benefits, risks, and challenges associated with project bundling among various STAs. The survey found that many STAs have been practicing project bundling but most frequently on bridge projects compared to non-bridge projects. The survey, however, revealed that a significant number of STAs find no significant differences between bundling bridge and non-bridge projects in terms of practices. The only difference mentioned in the survey is that non-bridge bundling projects, like roadway projects that are often on interstates and high-volume roads, are in the same corridor whereas the bridge bundling projects can be expanded to a wider geographical area. Although the project bundling method is familiar to many STAs, very few of them have a standardized process and well-documented strategies. Nonetheless, most of the STAs properly assess the project's suitability for bundling and use it in the early phases, such as planning, programming, and design, to achieve maximum benefits.

According to the survey, the most frequently considered factors during the bundling of projects by STAs are work type, project type, spatial proximity, and project risks. STAs with a higher level of experience with bundling tend to consider more factors and consider them more frequently when building a project bundle.

Furthermore, the survey found that the delivery method for bundled contracts that is most frequently used by state DOTs is Design-Bid-Build (D-B-B) method followed by Design-Build (D-B) and Indefinite Delivery and Indefinite Quantity (ID/IQ) methods.

The most important findings of this survey are the advantages and impact of the project bundling method as well as the challenges faced by STAs during the implementation of bundling. The survey found that the major advantages or benefits of the project bundling are that bundling:

- reduces the cost of the individual projects in a bundle,
- reduces agency administrative costs,

- affords the contractor flexibility in scheduling an individual project around other projects, and
- reduces the project delivery time per project.

The major impact of the project bundling is found to be on time and cost of the project. The survey found that there are 0-20% perceived time and cost savings in bundled projects.

Despite various advantages associated with project bundling, there are still some concerns expressed by the STAs. For instance, project bundling can sometimes impose the risk of complexity and maximize the impacts, such as delaying the schedule and increasing the cost of repetition. There is also a risk of one component of the project delaying the entire contracting process when other components in a bundle are ready to be contracted out. However, the survey found that these risks can be managed by early assessment of the needs of the projects that are in a bundled contract before bundling. Overall, the level of concern over most of the challenges described in the survey is found to be decreasing with the increase in the level of experience with bundling. Thus, standardized processes and well-documented strategies can play an important role in the effective implementation of the bundling method. The current survey also shows that the rate of standardizing the process of bundling has increased compared to the result of the AASHTO COC Contract Administration (CA) section's survey conducted in 2018 (*7*). However, very few STAs have developed their own guidebooks for the project bundling method, which might be a further step that STAs need to take.

Several STAs also expressed the concern of eliminating the competition from smaller contractors when bundling is used. The survey further found that there are also major concerns from small to medium-sized contractors reported by STAs regarding their ability to participate in bidding bundled contracts. Many STAs mentioned that some alternative contracting methods allow smaller contractors to partner up for larger projects, which may eliminate this concern. But the concern still needs to be further assessed because D-B-B has been predominantly used by the majority of STAs due to either the familiarity with the traditional method or state regulations.

CHAPTER 4: FOLLOW-UP INTERVIEWS AND CASE STUDIES

4.1 Introduction

The report presents the results of the second phase of the study. This research used a qualitative case-based method utilizing an open-ended questionnaire prepared for the online interview with the representatives from different state transportation agencies (STAs). The open-ended questions allow participants to present their perception of project bundling based on their experience with it (*25*). There is no such boundary as a closed-ended questionnaire structure. This enabled the participants to provide data sources for the effects of bundling in the project. Also, they suggested other experienced representatives for interviews.

STA representatives that participated in the earlier phase of the study were invited for the interview. A total of 16 representatives from different STAs participated in the interview. The participants involved varied in titles, including state construction engineers, contract engineers, construction oversight chiefs, program managers, directors, division chiefs, area engineers, administrators, specification engineers, and contract administration engineers. Each interview was conducted via. a web conferencing platform, Microsoft Teams, ranging from 30 min to 45 mins and took place from March 2021 to September 2021.

The survey questions focused mainly on the goals that the agencies set for bundled projects and how they approach bundling projects to achieve those goals. Questions regarding the impact of bundling, challenges they faced during bundling, risks observed in the method, and benefits of the bundling that the participants observed and experienced were asked during the interview.

The interviews were recorded, transcribed, and imported into a qualitative analysis software, NVivo. The software allows researchers to arrange the transcribed data, produce queries, create preliminary notes, code the interview data, recognize themes, visualize the data and conclude the analysis, reducing the manual method of qualitative analysis (*26*). Thus, the analysis was performed using NVivo. The transcribed interviews were repeatedly read and preliminary concepts about project bundling were noted by the research team. The “codes” were generated based on different concepts of bundling observed. The generated codes were then carefully

grouped based on the themes they represented. The coding schemes were based on the literature review and the data obtained from the project bundling survey of the first phase of the study. A deductive approach of qualitative analysis adopted helped categorize our codes into the major themes that reflected the best practice for bundling, including the definition of project bundling, bundling goals or objectives, general approach to bundling decision, the impact of bundling, assessment of project's suitability for bundling, unbundling strategies, risk management, consideration for smaller contractors, and funding sources.

4.2 Project Bundling: Definitions

Project Bundling is being widely used in bridge and highway projects as a contract procurement strategy. Federal Highway Administration (FHWA) defines the term project bundling as a process where multiple rehabilitation, repair, replacement, or preservation projects are combined to form a single larger contract (*27*). The multiple projects with different considerations, such as similar category, work type, size, and geographical locations, are combined into a single contract during project bundling. The term "Project Bundling", however, was found to be widely used only after an initiative of FHWA's Every Day Counts – 5 (EDC-5). The study found that the alternative procurement strategy was already being used by some of the State Transportation Agencies (STAs) with their own terminologies. The following describes the different terminologies, definitions, and methods that the different STAs have adopted for the project bundling.

4.2.1 Mandatory-Tie and Optional-Tie Projects

Mandatory-Tie projects are defined as projects that include multiple projects tied into one contract. Contractors do not have the option to bid separately on the projects in the bundle. Although multiple projects in a mandatory tie have their own project numbers and tracking numbers, there is only one bundled contract. On the other hand, in an optional-tie project, there is an individual contract for each project in addition to the bundled contract of the projects. The contractors can provide bids on individual projects as well as the bundled contract of those projects. The aggregation of the lowest bid costs of individual projects is compared with the

lowest bid among the bundled bids. Then, the decision of letting the project individually or as a tie (bundle) is made based on the comparison.

Oklahoma Department of Transportation (ODOT) has been using these terms to bundle projects for quite a long time. In general, ODOT usually prefers mandatory-tied projects to achieve efficiency, considering that the projects tied are within similar geographical proximity and are of similar project type and similar size. However, Oklahoma Statutes – Title 69, Section 1101 states that the construction contracts for the state highway systems should be let in accordance with the provision of the Public Competitive Bidding Act of 1974. Under this law, if a construction project length is greater than eight (8) miles of road, and is not a surface treatment only project, then ODOT should advertise the project bid for the smaller sections of the road project no longer than eight (8) miles, as well as the bids on the whole project as well. Such provision requires ODOT to create an optional-tie project. Thus, for example, if the agency has pavement resurfacing work to be done in a stretch of 24 miles of road, ODOT advertises the bidding for three 8-mile long roadway projects and also a 24-mile long road project as a whole. The main reason behind this law is to provide opportunities to smaller contractors to bid on smaller sections of the project.

It is rare to see that the aggregate of individual bids is lower than the bid for a bundled contract. But a representative from the Oklahoma Department of Transportation (DOT) mentioned that such an example exists in the record. The contractor once was awarded for the low bid on individual contracts of an optional tie. In general, in such an example it can be concluded that the bundling of those projects was not feasible in terms of the low bid received by the agency. Also, the benefit for the contractor to bid on separate projects rather than a bundle in that project was found to be better coordination of the schedules. The contractor mentioned that they can start and stop and complete the projects as they see fit. The contractor would have better control of the schedule in comparison to having one construction timeline for a bundled project.

An example of an optional-tie project was received from Oklahoma DOT (*28*). In March 2021, Oklahoma DOT advertised three contracts to bid where two contracts included individual projects (Call Order: 740 and 745) and the third contract was a bundled contract of those two individual projects (Call Order: 750 = 740 + 745). The individual projects had their own project numbers: STP-241C(071)3P and STP-241C(076)3P. Both projects were resurfacing (asphalt)

projects. The length of the first project was 6.28 miles while the other was 6.98 miles. The lowest bid for project STP-241C(071)3P that the agency received was $1,494,970.84 and that of the project STP-241C(076)3P was $1,683,424.06. The total cost of these two projects was calculated to be $3,178,394.90 if they were let as individual projects. However, the lowest bid on the bundled contract of these two projects having a total length of 13.26 miles was received as $2,998,726.10 which was less than the total aggregate of the two individual projects. Thus, Oklahoma DOT decided to bundle the project.

Table 16 below illustrates other examples of an optional tie project.

Table 16. Optional Tie Projects by Oklahoma DOT

Project Call Order	Project No.	Project Length (miles)	Engineer's Estimate	Low Bid	Remark
520	SSR-266C(092)SR	4.81	$1,513,543.36	$1,497,371.79	
525	SSR-266C(093)SR	7.20	$1,657,567.79	$1,631,571.00	
			Aggregate Cost	**$3,128,942.79**	
530 (Combined 520 and 525)	SSR-266C(092)SR SSR-266C(093)SR	12.01	$3,171,111.15	**$2,769,000.00**	Cost of Job 520 +525 > Job 530 Therefore, the project was bundled.
824	STP-273B(064)3P	3.975	$2,228,455.00	**$1,950,350.68**	
825	STP-273B(065)SR	1.520	$929,529.50	**$823,898.44**	
			Aggregate Cost	**$2,774,249.12**	
826 (Combined 824 and 825)	STP-273B(064)3P STP-273B(065)SR	5.495	$3,157,984.50	**$2,476,763.64**	Cost of Job 824 + 825 > Job 826 Therefore, the project was bundled.

Source: (28).

4.2.2 Soft-Tie and Hard-Tie Projects

Soft-Tied projects are the projects that are developed separately with their own set of bidding documents, specifications, sets of plans, etc. but bid together. The contractor has to bid on all the

projects included in the soft tie. The project is awarded to the lowest bidder based on the aggregate bid received on all the soft-tied projects.

Hard-Tied projects are like project bundling termed nowadays. The hard-tie projects include multiple projects developed such that their plans and specifications are all tied up into one bidding package. There will only be one bundled contract where all the quantities of the project are combined. A contractor, thus, bids on one contract.

To simplify, a soft-tied project contains multiple separate contracts but one contractor while a hard-tied project has only one contract and one contractor.

Example:

Nebraska DOT recently soft-tied two projects, an asphalt overlay concrete repair job with the project of installing high tensile barriers, which were within the same location/proximity. This soft-tie allowed the agency to avoid having two different contractors work at the same location.

In this type of bundling, the agency clearly mentions in the bid proposal that the contractor is required to bid on both projects that are soft-tied. The combined prices for the two projects from the contractor in the bid are looked at and the low bid contractor gets awarded. It is to be noted, however, that the contract items are not combined into one contract in the soft ties. The awardee will be responsible for all the projects that are in soft-tie.

The main advantage of the soft-tie is that, even after selecting the low bid contractor for the tied projects, if their bid is found to be too high in one of the projects in the tie, the agency can decide to reject that project and only build the other projects from that contractor. Another advantage of soft-tied projects is that if an issue occurs in one of the projects, the agency can continue with the other project that has fewer issues to prevent further construction schedule delays.

4.2.3 Combined (Tied) Projects and Optional Combination (Tied) Projects

Combined (Tied) Projects are like bundled projects where multiple projects are combined into one single contract. Iowa DOT's Contracts and Specifications Bureau occasionally provides Optional Combination Projects during project bundling. The main purpose of this is to balance the competition in the industry. In an Optional Combination Project, the projects that are decided to be bundled are also let individually and as a single contract (*29*). Thus, the contractors have an

option to bid on any or all of the individual projects. If the contractors have the capacity to bid on a larger group of projects, then they can also bid on the combined (tied) contract (bundled contract). The bid amount of individual projects and the bid amount of combined projects are compared. The lowest amount compared will be awarded the contract.

For example, if the agency decided to bundle four bridges in a bundle, in an optional combination (tied) option, each of the four bridges will also have an individual contract. This allows the smaller contractor to compete against the bigger contractors. The smaller contractor can bid on one or more of the bridge projects. Similarly, the bigger contractors can bid on the bundle of four bridges. If the lowest bid on the combined four bridge contract is lower than the aggregation of the lowest bids of the four bridges, then the award goes to the combined contract bidder and vice versa.

4.3 Bundling: Goals or Objectives

State Transportation Agencies (STA) try to achieve certain objectives or goals when they are using the project bundling method. The bridge bundling guidebook published by the FHWA (*30*) has listed major goals that different agencies can achieve through project bundling. The study found that the majority of the STAs utilize project bundling (PB) to achieve different objectives. Figure 17. represents the word frequency analysis performed in NVivo to highlight major goals mentioned by STAs during the interview.

Figure 17. Word Frequency Analysis of the Major Goals to Achieve during Bundling by STAs

The main objective of the majority of the STAs was found to be achieving efficiency in project delivery, construction process, and contracting methods. About 62.5% of the STAs that participated in the interview mentioned that they try to achieve ***efficiency*** in the construction methods and process by combining similar types of projects in a bundle. STAs like Rhode Island DOT were also found to be bundling two different types of work in a bundle to achieve efficiency in project delivery. For instance, if a bridge and the road that carries that bridge both need some repair works, then these types of projects were found to be bundled by the agency. It was found that this approach helped the agency in a way that the designated route was disturbed only once, instead of twice, resulting in reduced traffic detours and minimizing the disturbance to the public travel. Thus, allowing STAs to achieve efficiency in project delivery. STAs also believe that having one prime contractor responsible for multiple projects at a time can make the administrative work easier and more efficient.

Cost savings was another major objective of most of the STAs that participated in the interview. The major cost savings goals set by about 83.3% of the STAs that participated in the interview were lowering bid prices, lowering unit costs, reducing administrative costs, and saving mobilization costs. The main reason behind bundling the projects into a single contract for the majority of the STAs was to get an optimized size of the projects so that the competition in bidding is increased. Thus, it lowers the bid prices. The goal is to eventually achieve economies

of scale. The project bundling combines different elements into a single contract. Thus, a bundled contract will require only a single project manager, a single set of construction managers, and a smaller number of internal staff. This helps different STAs achieve the goal of reducing administrative costs. Some STAs also believe that letting each of the bridge works that are in a similar geographic location individually will have higher mobilization costs compared to that of bundled bridges.

Other goals or objectives that the STAs try to achieve through bundling are increasing contractor resources by attracting new contractors in the state, lessening the administrative paperwork, creating ease in oversight works, etc. Some STAs chose to bundle to utilize the available funding within a certain timeframe to replace a certain number of bridges.

Thus, the major goals or objectives that STAs try to achieve for project bundling can be illustrated using Figure 18.

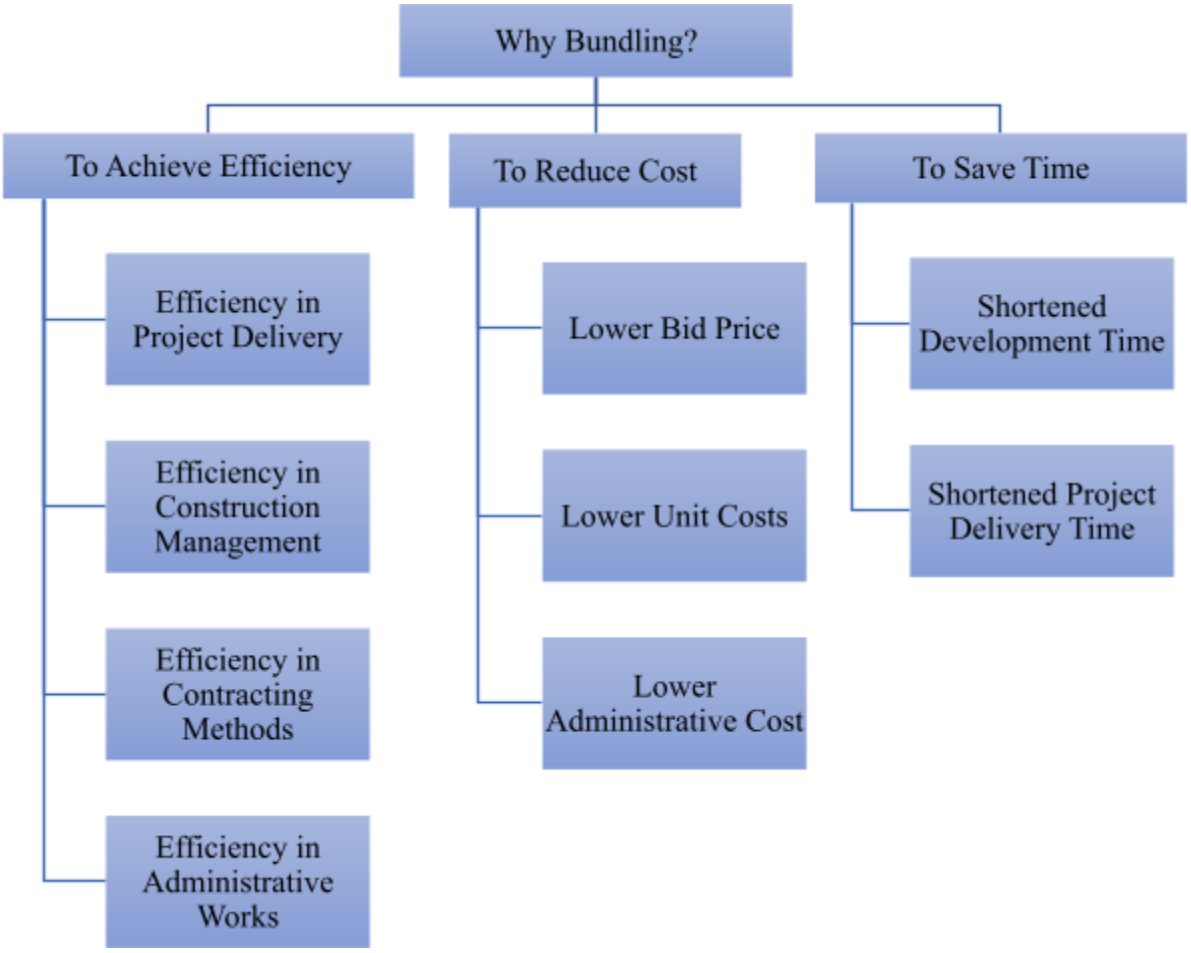

Figure 18. Mind Mapping of Major Objectives that STAs Achieve through Bundling

4.4 Bundling Approaches

The study found that the STAs have defined goals or objectives to bundle projects. The majority of the STAs bundle projects to increase the quantity of the project so that the competition among bidders can be achieved. So, the first step in the general approach of STAs towards bundling is to set a defined goal or objectives of bundling.

The bundling decision is then made as early in the project phase as possible. STAs decide to bundle any projects in the early phases of the project, such as planning or scoping. The bundling decision that is made earlier will provide more opportunities for the agencies to make the projects work together. Also, it will provide more flexibility in the design of the projects.

For instance, Texas DOT (TXDOT) makes bundling decisions early in the planning phase of the project. The central planning group at TXDOT, Transportation Planning and Programming Group separates funds into different categories and assigns them to the districts. There are twenty-five districts in the state. The districts have a District Planning Group that decides on how to move forward with the funding they received. Each district in the state has areas with experienced Area Engineers. The area engineers have good knowledge about the contractors in the area, the roads, and different projects. They study the benefits of bundling the projects. The area engineers then provide insights to the district planners and work concurrently with central planning staff to bundle projects during the planning phase. Finally, the design staff is handed over the projects if the decision is made to bundle.

In Iowa DOT, the district offices take the lead in determining what projects are to be bundled based on the work type.

The most common approaches that STAs adopt during bundling decisions are

- scope based approach; and
- location based approach

4.4.1 Scope of work

In a bundled contract, one prime contractor gets the projects. So, the projects that are bundled need to be in the contractor's area of expertise although they may hire subcontractors for specific tasks. For this reason, STAs believe in putting together projects having a similar scope of work in a bundle.

Examples of projects that can be bundled due to similar scope of work include resurfacing projects, maintenance projects like cable barriers, and so on. Typically, bridge projects are not bundled with these types of projects even though they are in the same geographical location.

In a scope-based approach, if the purpose or scope of the projects is similar, they may not necessarily be in the same location. If there are projects like bridge superstructure replacement within a certain region but not in the same location, it might be beneficial to bundle them together. Another example of the project for scope-based approach includes intelligent transportation system (ITS) projects. The ITS projects might be over an entire region but share a similar scope of work. So, these projects may be bundled. Similarly, several historic culverts

might require repair or replacement. Such projects share a common permit process and scope of work. Although they may be a few miles apart, STAs choose to bundle them. Such an approach helps STAs achieve economies of scale. However, STAs are aware that the location of these projects should not be very far apart such that the mobilization cost might not govern the project cost.

4.4.2 Location-Based Approach

Another approach that most of the STAs take during bundling decisions is location-based. The projects in a bundle sharing similar scope of work but stretching out across the state is not favorable to the STAs, which can increase contractors' mobilization costs and may also limit the resources available to the site.

The capabilities of the contractors in different geographical areas are also looked at during the decision on what to bundle. Thus, a location-based approach ensures that the projects in a bundle are either in the same corridor or in adjacent corridors that are just a few miles apart or in a similar location. This is also called a corridor-based approach by some STAs. RIDOT names this approach a geospatial approach. The agency has even developed an application to map everything and put the pieces together.

4.4.3 Other Factors considered during the bundling approaches

Once the agency considers one of the two major approaches towards bundling decision, various other factors are considered in the process, including construction schedule, public convenience, environmental permitting, utility relocation, and design (Figure 19).

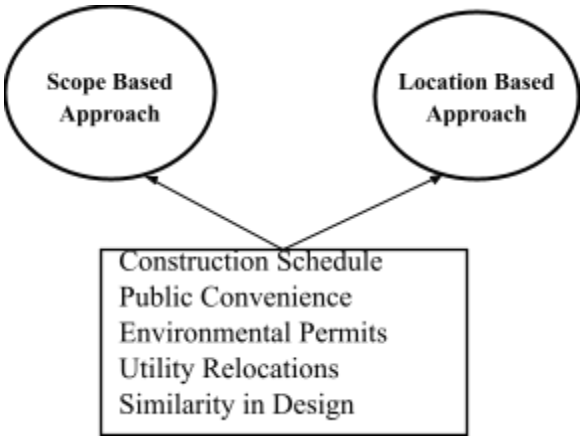

Figure 19. Project Bundling Approaches and Factors Considered by STAs

4.4.3.1 Construction Schedule

The projects that have similar project schedules and design schedules and that will be ready to let around the same time will be considered in a bundle.

4.4.3.2 Public Convenience

Another important factor considered during the decision to bundle is public convenience. STAs pay close attention to the projects that have maintenance of traffic and traffic control intertwined with each other from the standpoint of management of traffic for the public convenience. For example, if a detour route of one of the projects affects another project that is in a similar location, they are bundled.

4.4.3.3 Environmental Permits and Utility Relocations

STAs also bundle projects together that have similar environmental permitting processes and utility relocations.

4.4.3.4 Similarity in Design

One of the goals of STAs is to achieve efficiency in design during bundling. STAs tend to bundle projects that are similar in design.

A good example of this approach can be seen in RIDOT's process where they had four projects on a stretch of a highway. The projects were a resurfacing of a highway in both directions, replacement of a bridge over the highway, and rehabilitation of two bridges over the highway. The bridges were similar in their structural age. All the projects were in the same corridor or stretch of the highway. The detour route had to be set up at the same time. Even the permit process and utility companies involved were similar. Thus, RIDOT bundled these projects into a single contract considering a location-based approach. Such a decision helped the agency gain efficiency in delivery time. Instead of having two construction seasons for each of the four projects individually, the bundled contract helped to have only two construction seasons for the whole bundled projects

4.5 Impact of Bundling Observed on Projects

The first phase of the survey revealed the perception of STAs that the bundling method could potentially save about 0-20% of the time and the cost of the project. Currently, the quantification of time savings was not possible due to the lack of the amount of the collected data. However, to quantify the cost savings due to the bundled contracts, the dataset of optional-tie projects was obtained from the Oklahoma Department of Transportation (*28*). The data included the bundled projects awarded from 2017 to 2021 in Oklahoma through the Optional-Tie method. There were 16 optional-tie contracts in the dataset that were awarded to different contractors. The project types included asphalt resurfacing, safety improvement projects (such as rumble strip and pavement marking), pavement rehabilitation, bridge and approaches, bridge rehabilitation, and miscellaneous projects (such as grade, drain, and surface projects). The sum of the lowest bids of individual projects inside a bundle was compared to the lowest bid of the bundle of those projects in an Optional-Tie Contract. It is also important to note that Oklahoma DOT considers factors, such as the similar scope of work, and proximity to the geographical location of the projects before bundling. Also, the main goal of the agency was to lower the cost of the project by bundling.

Table 17. represents the comparison performed in the dataset to quantify the cost savings due to bundling. The results showed that the bundling helped the agency save 0-20% of the cost of the projects.

Table 17. Cost Savings due to Bundling

SN	Low Bid received for P1	Low Bid received for P2	Sum of Low Bids received for Individual Contracts	Low Bid Received for Bundled Contract (P1 + P2)	Cost Savings	Percentage Cost Savings
1	$2,627,133.38	$3,705,880.12	$6,333,013.50	$5,967,000.00	$366,013.50	**5.78%**
2	$0.00	$0.00	$0.00	$1,978,831.66	N/A	N/A
3	$1,950,350.68	$823,898.44	$2,774,249.12	$2,476,763.64	$297,485.48	**10.72%**
4	$1,494,970.84	$1,683,424.06	$3,178,394.90	$2,998,726.10	$179,668.80	**5.65%**
5	$1,497,371.79	$1,631,571.00	$3,128,942.79	$2,769,000.00	$359,942.79	**11.50%**
6	$0.00	$0.00	$0.00	$2,435,259.90	N/A	N/A
7	$0.00	$0.00	$0.00	$803,266.40	N/A	N/A
8	$0.00	$0.00	$0.00	$3,218,681.82	N/A	N/A
9	$0.00	$0.00	$0.00	$17,480,714.51	N/A	N/A

SN	Low Bid received for P1	Low Bid received for P2	Sum of Low Bids received for Individual Contracts	Low Bid Received for Bundled Contract (P1 + P2)	Cost Savings	Percentage Cost Savings
10	$11,211,392.98	$7,423,186.28	$18,634,579.26	$17,864,751.39	$769,827.87	4.13
11	$0.00	$0.00	$0.00	$2,425,000.00	N/A	N/A
12	$1,495,404.12	$819,560.40	$2,314,964.52	$2,175,792.02	$139,172.50	**6.01%**
13	$15,772,809.20	$15,206,424.72	$30,979,233.92	$28,621,809.91	$2,357,424.01	**7.61%**
14	$1,681,515.12	$1,949,193.75	$3,630,708.87	$3,598,708.87	$32,000.00	**0.88%**
15	$1,672,180.00	$1,436,650.00	$3,108,830.00	$3,160,478.00	-$51,648.00	-1.66%

Note: $0 indicates that there were no bids received for that project

This comparison also highlighted the benefit of the optional-tie method. In project No. 15 as shown in Table 17, the lowest bid received for the bundled contract of two asphalt resurfacing projects was higher than the sum of low bids received for those two individual contracts. Thus, the agency decided not to bundle the two projects. The project was thus awarded to individual contractors and let individually.

The number of bids that the agency received in the individual contracts was also compared to the number of bids received in the bundled contracts of those individual projects (Table 18). Figure 20 represents the comparison between the maximum number of bidders obtained per individual contract and the number of bidders received for bundled contracts. It was found that the bundling of the projects helped increase the number of bidders. The higher the number of bidders the higher the market competition for the agency, which eventually helps them to achieve lower costs. The number of bidders, however, may decrease if the contract size is too big, and the number of projects in a bundle is very large (*31*).

Table 18. Number of Bids Received by Oklahoma DOT in Optional Tie Projects

SN	No. of Projects in a Bundle	No. of Bidders in each individual contract	Maximum no. of bidders per individual contract	No. of Bidders in Bundled Contract
1	2	1, 1	1	2
2	2	0, 0	0	4
3	2	1, 1	1	5
4	2	1, 1	1	7
5	2	3, 3	3	6
6	2	0, 0	0	3
7	2	0, 0	0	2
8	2	0, 0	0	3

SN	No. of Projects in a Bundle	No. of Bidders in each individual contract	Maximum no. of bidders per individual contract	No. of Bidders in Bundled Contract
9	2	0, 0	0	2
10	2	2, 1	2	2
11	2	0, 0	0	3
12	2	2, 1	2	3
13	2	1, 2	2	0
14	2	3, 3	3	2
15	2	1, 0	1	3

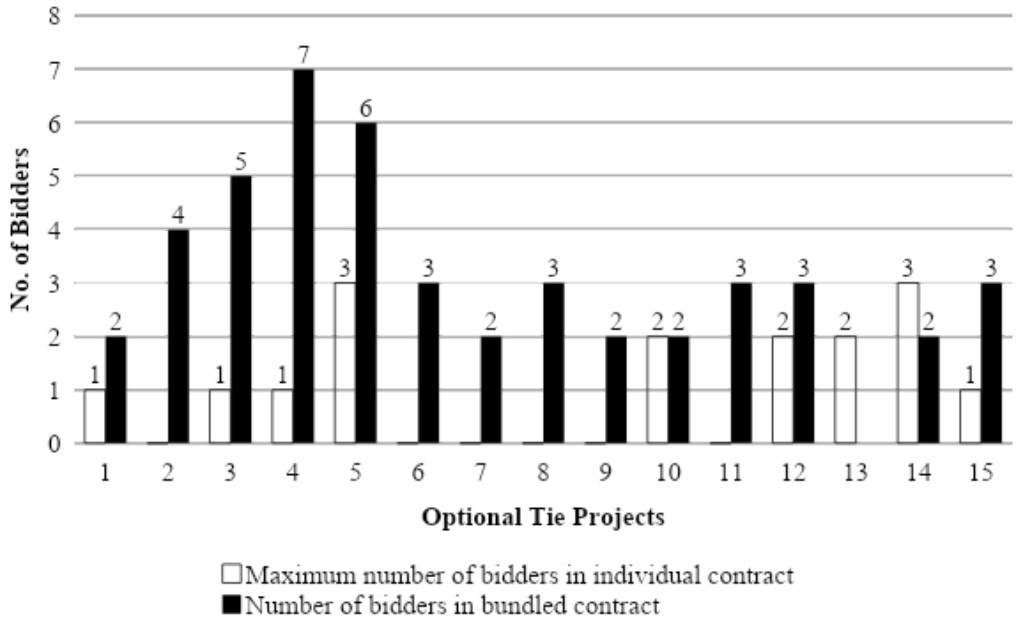

Figure 20. Comparison of the Number of Bids Received Per Individual Contract Vs. Bundled Contract

Further, the majority of the STAs perceived that there is no impact of the bundling method on the quality of projects. In this study, STAs mentioned that the quality of the project cannot be perceived to be affected by bundling alone. The quality of the project depends on the performance of the contractor on the job and the overall involvement of the staff and their coordination with the contractor on the project, whether it is bundled or unbundled. STAs follow standards and specifications to maintain quality in all kinds of projects. However, one of the benefits of bundled contracts is the similarity of the project. This might help in maintaining

consistency in the project. Also, the lessons learned from the challenges of a previous project in a bundle can act as a precautionary step towards the next project.

4.6 Assessment of Project Suitability for Bundling

The study found that the majority of the STAs have not developed any selection tools to assess the suitability of the project for bundling. It is mostly a collaborative effort between different stakeholders in the agencies when it comes to decision making. The evaluation of the project is made early on in the project phase, such as during scoping. The evaluation is based on the major factors mentioned above to consider bundling.

Only a handful of the STAs mentioned that a selection tool for the projects to be bundled has been developed by them. Idaho DOT, in the early phase of the project, reaches out to the district to check what projects the district has under Idaho Transportation Improvement Plan (ITIP). The projects are thoroughly reviewed by considering various factors, such as location, the scope of work, and so on. The selection tool was developed in the agency to select the right and complex projects that might benefit from bundling. Sometimes, the decision is also made by districts to bundle simple linear projects, such as seal coats, if the evaluation reveals the advantage of bundling those projects that are similar in design and construction.

In TXDOT, the District Director of Planning and Programming has developed a spreadsheet that includes the condition of the roadway and the project management information system of land survey data. The road conditions are rated as poor, bad, and good to go. The evaluation is then made based on which projects need attention and can be benefited from bundling together.

Similarly, for bridge projects, TXDOT has a BRINSAP program that rates the bridges, their rails, decks, substructures, foundations, and superstructures. The bridge inspection is carried out every two years. After the inspection, the bridge is rated, and the life expectancy of the bridge is determined. The bridges that are approaching the end of their life expectancy are bundled together. The major factors mentioned above considered during bundling are examined and the feasible bridge projects are bundled together.

A similar approach is taken by Montana DOT during the assessment of the project's suitability for bundling. The agency hires consultants to perform a preliminary analysis of the projects. The analysis includes the assessment of various issues such as hydraulic, environmental, right of way, wetland, migratory birds or species, wildlife, cultural issues, etc. The preliminary recommendations, project schedule, and cost estimates are provided, and a bundling decision is made.

4.7 Un-bundling Strategies

The projects in a bundle may need to be unbundled during the process in the later phases of the projects due to various reasons. The study revealed the major issues that can cause State Transportation Agencies to unbundle or uncouple a project from a bundled contract. These issues were funding, design, scheduling conflicts, permitting process, utility relocation, railroad, right of way, and sometimes administrative errors.

Most of the time it was found that the permitting process plays an important role in unbundling the projects. STAs may not be able to line up the permits for all the projects in a bundle. For instance, in a bridge bundle, one of the bridges might need a significantly different permitting process. This might cause a delay in the construction of other projects as well. So STAs take that project out of the bundle and let it separately later. It was found that a lot of times STAs have environmental permitting issues and occasionally right-of-way (ROW) issues.

Funding can be another factor considered by STAs to unbundle the projects in a bundled contract. For example, there might be three similar projects along the same corridor that were bundled. However, due to the lack of funding to fund one of the projects in the bundle it might get unbundled in the later phase.

STAs also decide to unbundle a project if a design issue emerges to cause other projects in a bundle to fall behind the construction schedule.

Sometimes, small utility relocation problems can occur. Even if a decision to bundle is made early on, some utility relocation issues can only be identified at the design phase of the project.

At that point, STAs may decide to unbundle the project that causes the problem and move ahead with the rest of the project in the bundle.

Another important factor that might cause STAs to unbundle the project in a bundled contract is railroad coordination. An example of this was shared by a representative from Michigan DOT. In a five-mile section of a freeway, a couple of interchange projects and some bridge projects may be bundled. However, if a bridge project in that bundle has railroad coordination issues that might delay the whole construction schedule, then the project is taken out of the bundle. Michigan DOT sometimes may reduce the scope of the project, such as taking out a section of freeway in the bundle to avoid such issues.

Thus, it is seen that STAs occasionally unbundle a project from the bundled contract to prevent the risk of overallocation of funds and construction delay. Those risks might eventually impact the unit cost of the project too. However, STAs also should be careful while unbundling the project. Unbundling a project in a bundle with interlinked design aspects might create a situation where designers might have to redo the whole plan causing inefficiency on the back end.

4.8 Risk Management

Project risks are inevitable. There is always a probability of uncertain events or circumstances that can affect the project's goals or objectives. The risks can either be a threat or an opportunity to the project. Risk management, thus, can help an agency quantitatively assess the probability of occurrence of the risks and identify the threats to, and opportunities for their bundling goals and objectives (*32*).

The first phase of the survey revealed that the STAs with a high level of experience with bundling consider project risks more often than STAs with a low level of experience with bundling do. The case study interview also revealed that the majority of the STAs do not have a formal risk assessment strategy developed for bundling. Only a few STAs mentioned that they have their own risk registers, and they perform formal qualitative as well as quantitative risk assessments of the bundled projects. A few examples of the risk management strategy followed by those STAs are presented below.

4.8.1 Colorado Department of Transportations (CDOT)

CDOT has developed the risk workbook to assess the risk and apply risk management toward bundling (*33*). The risk workbook developed by CDOT follows four principles of risk management, including risk identification, risk analysis, risk response strategy, and risk monitoring and control.

4.8.1.1 Risk Identification:

The tool allows users to input the risks that were identified. To identify the risks or threats to CDOT's transportation system, they created a risk register in 2013 and later updated it in 2018 with the help of the Transportation Asset Management Risk Task Force comprising of asset managers, project delivery teams, and other experts. The register includes various risks or threats categorized into three categories: social, environmental, and economic. It acts as a primary tool to record risks and helps in assessing the identified risks.

The spreadsheet includes the date and project phase when the risk was identified. The user of the tool must describe the type of risk identified. The tool also takes an input of the symptoms or warning signs that indicate if the risk is likely to occur. Alongside, the area (scope, schedule, or budget) on which the identified risk has the most impact is also recorded in the tool.

4.8.1.2 Risk Analysis:

The risk identified in the spreadsheet is then analyzed. The severity of the identified risk is rated based on its likelihood and impact on the project. The rating is either, low or high. The Risk Heat Map (Risk Level) is then calculated based on the analysis. The risk register that was updated in 2018 and 2019 by CDOT has provided scoring rubrics for the risks and their impact level.

Risk Score

CDOT has developed its own methodology to determine the ranking score of the risk. The risk score is calculated by CDOT using the following formula:

$$\textbf{Risk Score} = T \times C \times V \ldots\ldots \textbf{Eq 2}$$

where,

T = Threat Likelihood or probability that the event will occur

C = Consequences and Consideration of the risk event

V = Vulnerability of CDOT to risk consequences

i. **Threat Likelihood (T)** is defined as the probability that any risks or threats will occur. The scaling rubric developed in the risk register by CDOT provides a numeric value (1 to 5) depending on the occurrence of the risk event. The variable was developed based on predictive analysis of the frequency of the event or risk that occurred and experts' judgments (Table 19).

Table 19. Threat Likelihood

Level	Descriptor	Description	Annual Probability Range	Probability
1	Low	50+ years between events	<2%	1.0%
2	Medium – Low	20 to 50 years between events	2% to 5%	3.5%
3	Medium	5 to 20 years between events	5% to 20%	12.5%
4	Medium – High	1 to 5 years between events	20% to 100%	40.0%
5	High	Once annual occurrence or greater	100%	99.0%

ii. **Consequence and Consideration (C)** is defined as the impact that was caused by the risk or threat event. CDOT has included four major areas of the project in their risk register where the risks or threat events could have an impact. They are safety, mobility, asset damage, and other financial impacts. The impact is measured in numerical values from 1 to 5, with 1 being negligible or low impact and 5 being severe or critical impact.

To quantify the impacts that any risk could have on the project, CDOT included five major consideration variables in the register:

- **Funding**: considering if enough funds are available to deal with the risk event and its impact
- **Insurance**: considering if the current insurance level covers the potential threat and its impact
- **Regulatory**: considering if current federal, state, or local regulations inform CDOT planning and response to a risk event.
- **Political**: considering if any risk event influences political interest and interference,

- **Reputation**: considering if the risk event affects the reputation of CDOT as well as relevant stakeholders

The value of 0.05 is assigned to each consideration that is relevant to the risk identified. The numerical values assigned to consequences and considerations are then combined to obtain a total C score using the following equation:

$$\mathbf{C = O_s \times [(S_s + M_s + D_s + F_s)/4]} \text{ …….Eq. 3}$$

where,

O_s = Value assigned to Considerations = 1 + (0.05 × [Number of Considerations Selected])

S_s = Value assigned to Safety variable

M_s = Value assigned to Mobility variable

D_s = Value assigned to Asset Damage variable

F_s = Value assigned to Other Financial Impact variables

iii. **Vulnerability (V)** is the measurement of how vulnerable the CDOT's asset management system and response planning are compared to the potential threat or risk event which can be natural or manmade events. The numeric values, 1 to 5, are presented in the risk register with one being less vulnerable to the event and five being very highly vulnerable to the event. The very low vulnerability score indicates that the agency is well prepared and resilient enough to the threat or risk identified.

4.8.1.3 Risk Response Strategy

Once the Risk Heat Map (Risk Level) is identified based on the analysis, CDOT developed a risk management tool or spreadsheet that helps the project manager or any user develop strategies to deal with risks. The strategies include avoiding the risk, transferring the risk, mitigating the risk, accepting the risk, exploiting the risk, enhancing the risk, or sharing the risk.

4.8.1.4 Risk Monitoring and Control

The Risk Management Workbook or spreadsheet also helps maintain the record for the next planned date to review those risks for proper monitoring and controlling of the risks. The risk

register designed by CDOT helps monitor the risks that are of very high priority. To control the risks, CDOT updates the register regularly with the help of their Asset Management Risk Task Force. CDOT monitors the risk utilizing various databases and inspection reports from the agency's respective asset programs. For instance, the bridge program of the agency has an inventory of bridges at risk, such as bridges that have low vertical clearance, scour-critical bridges, bridges that were found to have leaky expansion joints, etc. CDOT evaluates the performance measures of these risks allocated to bridges and tries to reduce the percentage of bridges that fall into these categories.

Table 22 (shown in the later section of the report) provides a link to the website of CDOT including the risk management tool and further information on their strategies for risk management.

4.8.2 Montana DOT (MDT)

Montana DOT utilizes a tool developed in 2009, the Risk Management Plan (RMP) spreadsheet, to perform risk identification, management, monitoring, and control (*34*).

4.8.2.1 Risk Identification

The first part of the RMP spreadsheet is to identify risks. Risk management is a continuous process that begins in the planning phase of the project and continues until the end of the project life cycle. The tool allows project managers (PM) to input the following information that helps identify the type and status of the risk.

- **Risk Status:**

It helps identify if risks are actively being monitored and controlled, of a low priority in the current situation, or no longer a threat to the project.

- **Risk Breakdown Structure:**

MDOT introduced various categories of risks to track the risk management process efficiently. The main categories per risk breakdown structure (RBS) were right-of-way (ROW), environmental (ENV), engineering/construction (ENG), traffic (TRF), stakeholders (STK), unforeseen events (UNF), market condition (MKT), and utilities (UTL). During the risk

identification process, the project team uses their engineering judgment and experience in assigning the identified risks to appropriate categories.

Figure 21 represents an example of RBS coding used by MDOT during risk identification. For better record-keeping and risk identification, an alphanumeric code is provided for each risk. For example, the risk of having a disagreement on highway access falls under the right-of-way category and is coded as **ROW-01**.

- **Project Phase:**

The tool also records the phase of the project when the risks were initially identified. Project phases are categorized into planning, survey, design, ROW, and construction.

- **Functional Assignment:**

The respective section of the office that will be responsible for the response to the risks identified can be selected. The options listed in the spreadsheet are bridges, consult, Construction Techniques, Equipment and Practices (CTEP), district, environmental, Helena, safety, traffic, Right-of-Way, utilities, Geotech, survey, construction, and legal.

- **Threat or Opportunity:**

The tool maintains a record of whether the identified risk is a threat or an opportunity to the cost and schedule of the project.

	ROW	ENV	ENG	TRF	STK	UNF	MKT	UTL
	Right-of-Way	**Environmental**	**Engineering/ Construction**	**Traffic**	**Stakeholders**	**Unforeseen Events**	**Market Conditions**	**Utilities**
01	Disagreement on highway access	Permits /agency actions delayed	Sufficiency of plans and specifications	Design change	Objections from local communities	Forest fires	Labor	Coordination with local utilities efforts
02	Objections to R/W appraisal	Agency disputes not resolved in a timely manner	Change in seismic criteria	Traffic growth	Late changes requested by stakeholders	Weather related incidents	Fuel	Utility negotiations
03	Acquisition issues	New information required for permits	Soil and other geotechnical conditions / mat'l availability	Land use changes/ developments	New stakeholders demanding new work	Earthquake	Materials	Delay caused by utility conflict
04	Volatile real estate market	Environmental regulations change	Soil contamination		Threats of lawsuit	Man-made disasters	Land	Railroad involvement
05		Additional environmental analysis required	Contractors / subcontractors capability		Stakeholders choose time and/or cost over quality	Economic changes / funding availability		
06		Design changes initiated by Resource Agency	Work zone safety and mobility		Tribal Employment Rights Office (TERO) fee			
07		Tribal issues	Site specific requirements		Overlapping Governmental Jurisdictions			
08			Drainage / hydraulic issues					
09	Staffing issues	Staffing issues	Staffing issues	Staffing issues				Staffing issues
10	Other	Other	Other	Other	Other	Other	Other	Other

Figure 21. Risk Breakdown Structure Categories [Source: (*34*)**]**

4.8.2.2 Risk Description

Once each risk is identified and categorized, a brief description is included in the spreadsheet to describe the cause of the risk and the impact it might have on the project.

4.8.2.3 Risk Trigger

This section helps to provide information about an event that a risk is likely to occur.

4.8.2.4 Risk Analysis

After the risk is identified, the RMP tool performs risk analysis, qualitative and quantitative, based on the input from the PM. The anticipated impact of the risk event is calculated by the spreadsheet using the Program Evaluation Review Technique (PERT) formula

$$\textbf{Anticipated Impact} = Probability \times \left(\frac{Min+4\times Most\ Likely+Max}{6}\right) \quad \textbf{.....Eq. 4}$$

The probability of occurrence is categorized into subheadings: Very Low (VL), Low (L), Medium (M), High (H), and Very High (VH) with the respective probability being 5%, 25%, 50%, 75%, and 95%. For maximum, and minimum risk impact, a value is entered in the tool assuming that the risk impact, if it occurs, will not be higher or lower than the values input respectively. The most likely risk impact in the cost represents the most frequent cost impact

value incurred by the event. The subheadings can be entered into the tool for qualitative analysis. If the quantitative analysis is performed, the probability of occurrence is automatically calculated based on the risk's minimum, maximum, and most likely value input. The impact of the risk identified on the cost and schedule is thus calculated.

4.8.2.5 Risk Response

The RMP tool allows to input the response strategy to the risks that were identified and quantified. The strategies for the risks are either to avoid, transfer, mitigate or accept. Similarly, for the opportunities that were identified, the strategies would be to accept, exploit or share.

4.8.2.6 Risk Matrix

The risk matrix of the probability of occurrence of the risk versus the impact of the risk on the project is generated in the tool based on the qualitative and quantitative analysis of the risk identified. Based on the risk matrix, risk response strategies can be determined. Figure 22 illustrates the strategy options that can be selected for the risk based on the risk matrix. For instance, if the probability of occurrence of the risk is very low (VL), and the impact of the risk is very high (VH) it is preferable to mitigate the risk based on the Risk Matrix.

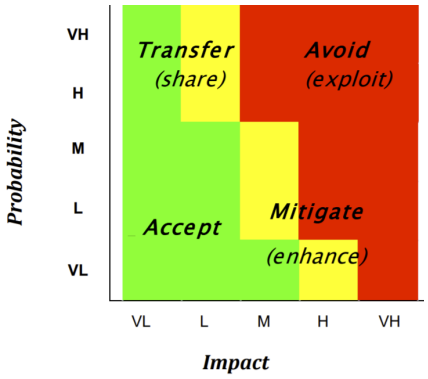

Figure 22. Risk Response Matrix [Source: (*34*)]

4.8.2.7 Risk Monitoring and Control

The risk monitoring and control process is followed by recording the dates when the risk would be revisited. The date when the risks were reviewed and additional comments are recorded in the tool.

If the risk is of urgent concern, then the NEAR option is selected in the tool. Otherwise, the LONG option can be selected which means that the risk will occur later in the project and is not of urgent concern.

4.8.2.8 Risk Response Cost and Cost Avoidance

Once risks are identified and analyzed as well as the corresponding actions to be taken are recorded, the planned cost of responses is maintained in the tool. The actual response cost is then recorded in the tool when the project is completed. The final cost required for the risk response can provide valuable input for future risk management purposes.

4.9 Considerations for Smaller Contractors

The major challenge that most of the STAs faced during project bundling was to provide equal opportunities to smaller or local contractors and avoid eliminating them from the opportunity to compete in bidding. Thus, in this study, STAs were asked about their concerns about this challenge and how they were overcoming this issue while utilizing project bundling.

The study revealed that the majority of the STAs overcome this challenge by limiting the size of the bundle so that smaller contractors can also be involved in the bidding competition. For instance, whenever possible, they would bundle 2-4 bridges together instead of 15-16. STAs also mentioned that they let out singles, small bundles, and large bundles occasionally. So, different sizes of contractors in the industry could get a chance.

Further, STAs communicate with the industry on a regular basis to get feedback from the contractors as well as provide training and workshops to the contractors about bundling. A good example of this would be the establishment of the Innovative Contracting Working Group by Idaho DOT. The group consists of people from the American Council of Engineering Companies (ACEC), the consultant community, Associated General Contractors of America (AGC), and the contracting community. The agency works together with the group to discuss the upcoming bundled projects. Idaho DOT with the group organizes a pre-advertisement meeting before projects go out for bid so that the contractors in the area are aware of the work in the upcoming bundled projects.

Similarly, Montana DOT provides training and workshops to AGC and contractors in the state. The contractors are provided with knowledge about upcoming bundling projects.

4.10 Funding Sources for Bundling

The study revealed that the primary sources of funding for bundled projects include federal, state, or local governmental entities. The primary objective of the federal grants is to implement innovative practices in construction projects. For instance, FHWA recently granted $5.6 million to the Michigan Department of Transportation under the Accelerated Innovated Deployment (AID) Demonstration program for bridge bundling (*35*). The projects that are federally funded are however required to meet the federal regulations.

It was also found that the STAs do not prefer combining state and federal funding in a bundle to avoid additional administrative works, such as tracking spending on both funding sources separately. In Texas, the agency breaks down both funding sources further into different categories, such as bridge funding (Category 6), District Discretionary Funding (Category 1), Traffic funding (Category 8), and Safety (Category 11).

4.10.1 Local funding sources

Other local funding sources are often leveraged to address structurally deficient bridges in a bundled manner.

4.10.1.1 Transportation Innovation Act (TIA) fund under County Bridge Match Program

The Country Bridge Match Program (CBMP) was created by the state of Nebraska envisioning the replacement and repair of structurally deficient (SD) bridges on the county system using an innovative approach, including bundling (*36*). CBMP provides Transportation Innovation Act (TIA) Funds to the participating counties matching up to 55% of the total estimated project construction cost. The engineering and project development phases, such as environmental permits, right-of-way, preliminary designs, and construction management, are funded by the county itself.

The selection criteria of the project proposals depend on seven different categories, including innovation, cost or time savings, sustainability of innovation, long-term savings on maintenance

cost, project risks, project needs, and equity. One of the major parts of the innovation is the bundling of the projects. The proposal gets a higher selection score if it contains multiple projects bundled together within the same county or bundled projects between different counties.

Table 20 illustrates one of the examples of the selected proposal under CBMP. In this project, Saline and Lancaster County of Nebraska State proposed the replacement of three SD bridges with concrete box culverts (CBC). One of the bridges lies in Saline County and the other two in Lancaster County. The three bridges with multi-country locations are proposed to be bundled to save cost and achieve efficiency. The proposal received a total score of 55.0 out of 100 points. The total estimated construction cost of the bundle was $915,000 and CBMP matched 55% of the cost equivalent to $503,250 for reimbursement. The strategic approach of bundling the projects between counties and its possible transferability of innovation to other counties by sharing their experiences helped increase the score of this proposal. Also, the bundling of the projects was prioritized by the program.

Table 20. Example showing Selected Proposal of CBMP 2020

Applying County	Lancaster	**Date of Application**	12/5/2019		**Proposal Name/Location**	Lancaster-Saline 2019		
Agency Name	Lancaster County	**Contact Person Title**	-		**Multi-County Proposal**	Yes		
Contact Person Name	-	**Address Line 1**	-		**Proposal Priority Number**	1		
Email	-	**Address Line 2**						
Phone Number	-	**Zip Code**						
NACO District	Southeast							
Structure Information								
NBI Structure Number	**Local Name**	**Location**	**Country**	**Existing Length (ft)**	**Existing Total Width (ft)**	**Existing Type**	**State Classification**	
C005545810	R-210	2.5S 3.1W OF BENNET at STREAM (R 210)	Lancaster	24.00	26.20	Steel Stringer/Multi-beam or Girder	Local	
C005516825	Y-181	2S 1W OF PANAMA at N FK BIG NEMAHA R(Y 181)	Lancaster	32.00	24.70	Steel Stringer/Multi-beam or Girder	Local	
C007604515P		1E 4.2N OF WILBER at STREAM	Saline	30.00	21.80	Steel Stringer/Multi-beam or Girder	Collector	

Eligibility								
NBI Structure Number	**Min. Maintenance Road (yes/no)**	**Advertised for Construction Bids?**	**Average Daily Traffic**					
C005545810	No	No	36					
C005516825	No	No	22					
C007604515P	No	No	160					
Proposal Construction Details								
NBI Structure Number	Proposed Action	Proposed Structure Type	Proposed Length (ft)*	Proposed Total Width (ft)*	Workforce	Total Estimated Bridge Cost	Anticipated Reimbursement from CBMP	Comment
C005545810	Replace	Concrete Box Culvert			Contract	$320,000	$176,000	Twin 10’x10’ CBC
C005516825	Replace	Concrete Box Culvert			Contract	$320,000	$176,000	Twin 10’x10’ CBC
C007604515P	Replace	Concrete Box Culvert			Contract	$275,000	$151,250	Twin 10’x10’ CBC
					Total	**$915,000**	**$503,250**	**OK**

Note: * Length and Width not required for Culverts.

[Data Source: (36)]

4.10.1.2 Statewide Bridge and Tunnel Enterprise

The interview found that the Colorado Department of Transportation (CDOT) utilizes the tax amount collected from gas for non-bridge projects. For the bridge bundling, CDOT has developed a program, called Colorado Bridge Enterprise.

Colorado Bridge Enterprise (CBE) is a government-owned business that was established in 2009 within the Colorado Department of Transportation (*37*). CBE is a part of the Funding Advancement for Surface Transportation and Economic Recovery (FASTER) legislation. The purpose of CBE is to finance, repair, replace, and reconstruct bridges whose conditions are rated as structurally deficient per Senate Bill-09-108 legislation.

CDOT imposes a bridge safety surcharge that ranges from $13 to $32 on vehicle registration based on the weight of the vehicles. It is estimated that the agency was able to generate approximately $100 million of annual funding from the bridge safety surcharge.

4.11 Project Delivery Methods for Bundled Projects

The first phase of the survey found that the STAs most frequently use Design-Bid-Build (D-B-B), and Design-Build (D-B) delivery method for bundled contracts. A few other alternative delivery methods were found to be used by STAs in bundled contracts, such as Indefinite Delivery and Indefinite Quantity (ID/IQ), Construction Manager/General Contractor (CM/GC), and Public-Private Partnership (P3).

The FHWA website has a wide range of information and case studies on project bundling. Following are a few examples excerpted from the website showing various STAs utilizing project bundling with different project delivery methods (*27*):

- Erie County (New York) under its Preventative Maintenance Bridge Bundling Program bundled contracts for bridge maintenance and used the D-B-B method. Similarly, under the New York State Department of Transportation (NYSDOT) Accelerated Bridge program, NYSDOT used both the D-B method and D-B-B methods. One of the bundled projects in western New York which used the D-B method covered a larger geographical area. The venture team of three contractors was formed and consequently, the project had a higher bid. To resolve this issue, NYSDOT rejected the higher bid, and the project was redesigned using the D-B-B method with bundles of smaller project sizes and in closer proximity.

- Ohio DOT (ODOT) completed 210 bridge repairs consisting of smaller bundles of two to three bridges per contract using the design-build (D-B) delivery method. Also, ODOT has been using the D-B-B method in its current projects. Other bridge bundling programs that have completed or ongoing projects using D-B and D-B-B methods are Missouri DOT (MoDOT) Safe and Sound Bridge Improvement Program, South Carolina (SCDOT) Bridge Bundling Program, Georgia DOT Design-Build Bridge Replacement Program, and Pennsylvania DOT (PennDOT) Local Bridge Bundling Program.

- Delaware DOT (DelDOT) has used the Indefinite Delivery- Indefinite Quantity (IDIQ) method in its bundled project to replace culverts. The detailed plan for five locations was completed by DelDOT and additional quantities were specified in the contract. The contractor was involved in the design of culverts at additional locations.

- Another type of delivery method used in bundled projects is the construction manager/general contractor (CM/GC). The bundled 11 major roadway projects including 13 bridge projects were successfully delivered using a CM/GC method by Osceola County (Florida) under its Roadway & Bridge Bundling Program (*27*).

Table 21 summarizes the delivery methods used by different STAs in the bundled contracts.

Table 21. Project Delivery Methods utilized by STAs during Bundling.

SN	State Transportation Agency (STA)	Delivery Method Used	Procurement Method	Project Types
1	Delaware DOT	D-B-B D-B-B, ID/IQ D-B CM/GC	Low Bid Low Bid Best Value Guaranteed Maximum Price	Bridge maintenance Culvert repair Culvert maintenance Bridge rehabilitation
2	Erie County, New York	D-B-B	Low Bid	Bridge preservation and maintenance.
3	Georgia DOT	D-B	Low bid – Contractors prequalified	Bridge replacement
4	Idaho DOT	D-B	Best value	Bridge replacement
5	Indiana DOT	D-B, and D-B-B	Low bid	Bridge, pavement, and other
6	Iowa DOT	D-B-B	Low bid	Bridge rehabilitation, and bridge replacement
7	Kentucky Transportation Cabinet	D-B-B and D-B	Low bid (D-B-B) and Qualification Based Selection (QBS)	Bridge rehabilitation
8	Missouri DOT	D-B, D-B-B	Low bid, best value	Bridge replacement
9	Nebraska DOT	Either Design-bid-build (D-B-B), with legislative authority for design-build (D-B) and construction manager/general contractor (CM/GC) Determined by the lead county	Low bid	Bridge replacement
10	New York State DOT	D-B-B	Low bid	Bridge preservation
11	City of Oakwood, GA	D-B	Low bid	Pavement
12	Ohio DOT	D-B	Low bid	Bridge replacement
13	Oregon DOT	CM/GC	QBS	Bridge replacement

SN	State Transportation Agency (STA)	Delivery Method Used	Procurement Method	Project Types
14	Osceola County, Florida	CM/GC	QBS	Bridge – new construction
15	North Hampton County, Pennsylvania	P3	Best value	Bridge rehabilitation, and replacement
16	Pennsylvania DOT	D-B-B, P3	Low bid	Bridge replacement
17	South Carolina Dot	D-B	Best value	Bridge replacement

The choice of project delivery methods for bundled projects is not a one-type-fits-all selection process. Different factors should be considered. For instance, a majority of the STAs use D-B-B by default unless the project meets certain criteria and is subjected to government officials to use other alternative project delivery methods. However, other alternative project delivery methods are gaining momentum as more states are practicing and more experience is accrued over the projects.

4.12 Best Practices for Bundling

The two phases of the study are concluded with the best practice flowchart for the bundling strategy. Based on the survey of the first phase of the study and the interview with various STA representatives from the second phase of the study, the best practices that were successfully applied by the agency during bundling are synthesized as a flow chart (Figure 23) in this section. To gain deeper insight into the best practices of each specific critical step in this framework, the readers can refer to the specific section of this report.

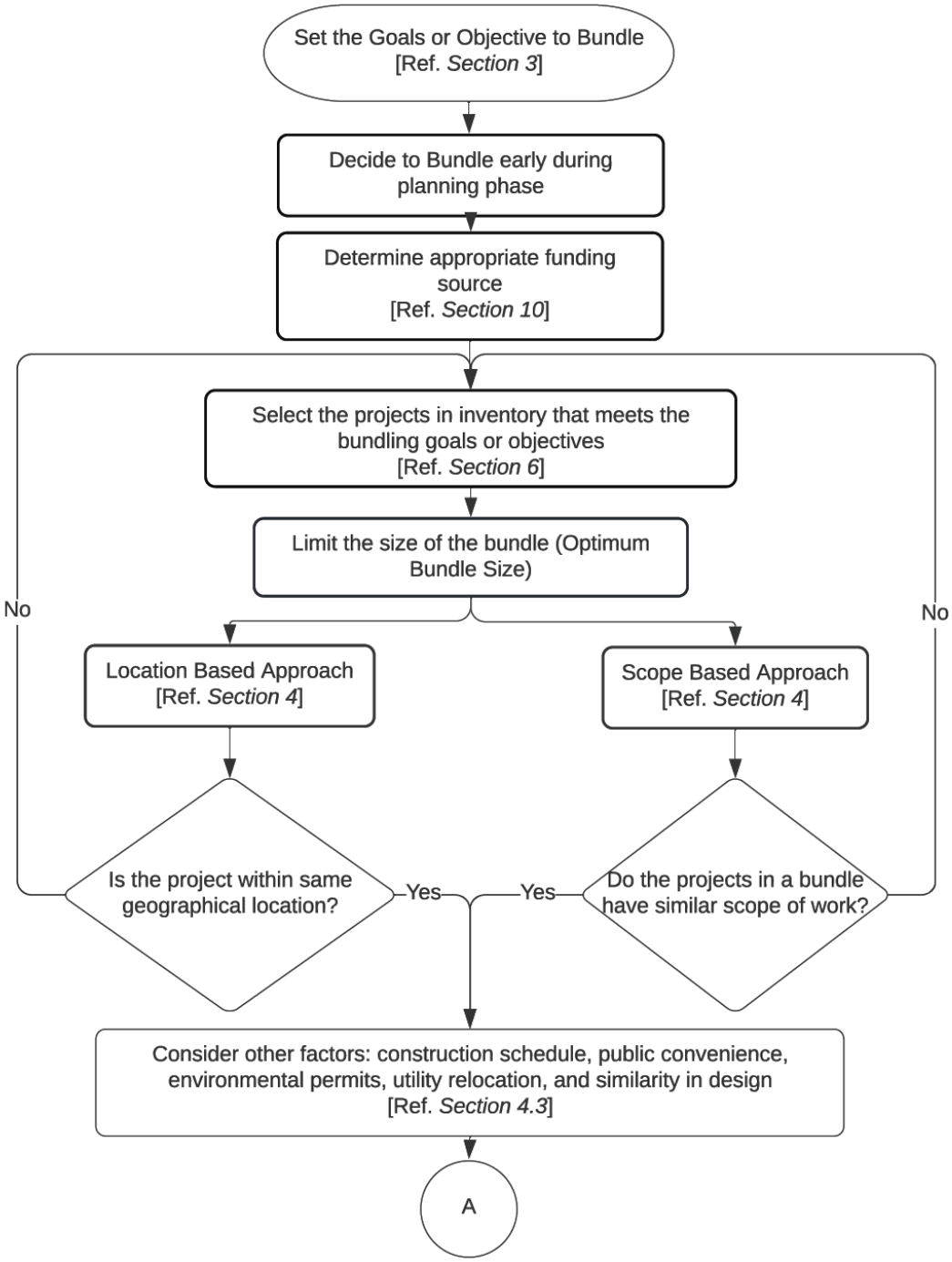

Figure 23. Best Practice Flowchart for Project Bundling

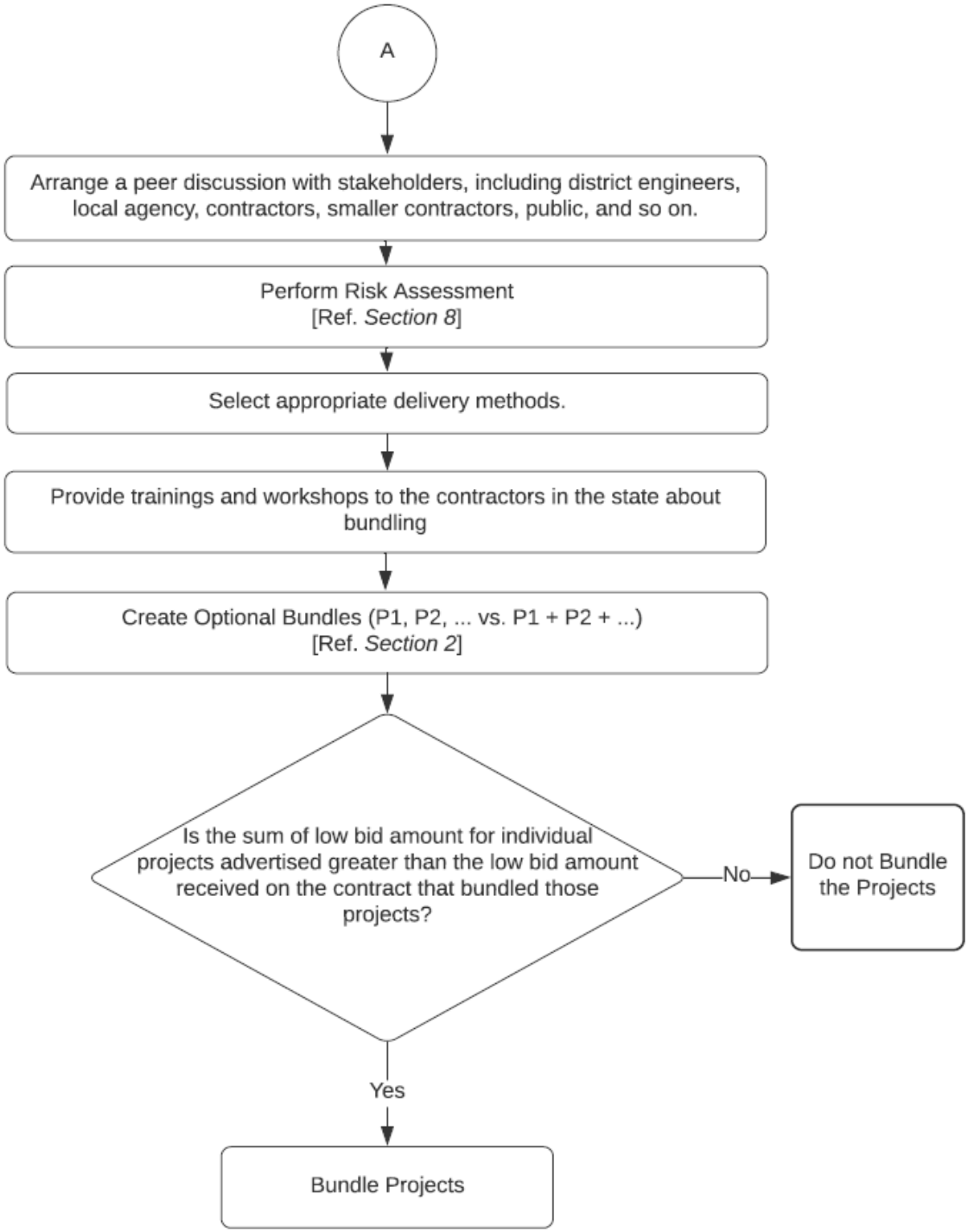

Figure 23. Best Practice Flowchart for Project Bundling (Continued)

4.13 Useful Resources

Table 22 represents the useful websites and articles covering a range of topics that helps STAs in bundling decision.

Table 22. Useful Resources for Project Bundling

SN	Information	Title	Author/s	Source
1.	Project Delivery and Procurement Methods previously utilized by STAs on bundling projects.	Bundled Project Case Studies	Federal Highway Administration (FHWA)	https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/case_studies.aspx
2.	Risk Management Workbooks and Process adopted by Colorado DOT	Risk Management	Colorado Department of Transportation	https://www.codot.gov/business/project-management/scoping/risk-management
3.	Provides information of Bundled Contract Size threshold.	Bundling Bridge and other Highway Projects: Patterns and Policies	Yu Julie Qiao, Jon D. Fricker, Samuel Labi, and Trevor Mills	https://journals.sagepub.com/doi/pdf/10.1177/0361198118797804?casa_token=KKSjC6152TsAAAAA:_MEgQiFhw4qmblTRfKV92SUM9DpFK_o0-daivASMK2MVR43IWVq0YSn-0EnsPfr4x9SL65f0orCu
4.	Peer Discussion for Environmental Permit Process and Quality Control	Interagency Office of Environmental Quality (IOEQ)	Georgia Department of Transportation	http://www.dot.ga.gov/AboutGeorgia/Offices/Pages/OfficeDivisionDetails.aspx?officeID=38
5.	Multi County Bundling Example	Iowa Local Technical Assistance Program: Local Agency Bridge Innovation	Iowa State University	https://iowaltap.iastate.edu/bridge-innovation-and-demo-days-videos/#perspectives_on_bridge_building_in_iowa
6.	Information of Combined and Optional Combination Projects	Innovative Contracting Methods	Iowa Department of Transportation	https://www.iowadot.gov/local_systems/publications/im/3730.pdf
7.	Advanced Project Bundling Techniques	EDC-5 Project Bundling Webinar Series	Federal Highway Administration (FHWA)	https://www.fhwa.dot.gov/ipd/pdfs/alternative_project_delivery/project_bundling_flyer.pdf
8	Guidelines for Bridge Bundling	Bridge Bundling Guidebook – An Efficient and Effective Method for Maintaining and Improving Bridge Assets	Daniel D'Angelo, Applied Research Associates, Inc. Barry Benton, Greenman-Pedersen, Inc. Thay Bishop, Romeo Garcia, and	https://www.fhwa.dot.gov/ipd/pdfs/alternative_project_delivery/bridge_bundling_guidebook_070219.pdf

SN	Information	Title	Author/s	Source
			Ken Atkins, Federal Highway Administration	
9	Risk Management Guide for Bundled Project	Advanced Project Bundling: Risk Management Guide	Douglas D. Gransberg, Ph.D., PE	https://www.researchgate.net/publication/353763330_Advanced_Project_Bundling_Risk_Management_Guide_1_ADVANCED_PROJECT_BUNDLING_Risk_Management_Advanced_Project_Bundling_Risk_Management_Guide_2
10	Recorded Webinars on Project Bundling	Project Bundling Webinar Series	Federal Highway Administration (FHWA)	https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/webinar_series.aspx
11	Collection of other resources listed by FHWA	Project Bundling Resources	Federal Highway Administration (FHWA)	https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/project_bundling_resources.aspx

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The study was concluded with a detailed survey, survey findings, and case study interviews with the representative from various state transportation agencies (STAs) that have experience with project bundling. The statistical analysis of the data obtained from the study confirmed that the majority of the STAs perceive the bundling method to reduce the cost of the individual projects in a bundle, agency administrative costs, and project delivery time. The project bundling method is also perceived to provide flexibility to the contractor in scheduling an individual project around other projects in a bundle.

There are not many published case studies and bundling guidebooks on the bundling of construction projects other than bridges. Thus, most of the STAs have been using bridge bundles. The survey conducted by AASHTO COC CA in 2018, however, has shown an increasing rate of utilization of the project bundling method in other construction projects, such as roadways. The majority of the STAs are found to adopt the bundling method to achieve efficiency in project delivery. The study also found out that the agencies believe the bundling saves 0-20% of the project time and cost while having no impact on the quality of the project. The quality of the project delivered, irrespective of the contract procurement method adopted, depends on the contractor selected for the job, the performance of the staff, and coordination between the team members.

The study recommends that the agencies, at first, create a list of the projects that they would like to bundle into a contract. The suitability of those projects then should be assessed earlier with respect to various factors, such as geographical proximity, project size, work type, project type, and project risks. This helps STAs in achieving greater efficiencies and better implementation of the bundled construction contracts. In some cases, the required information for some projects is only available at the design phase of the project. Such projects can be determined to bundle or not based on funding availability, risks involved in the bundled contracts, and other factors, such as maintenance of traffic, and utility relocation.

The study also recommends STAS standardize the bundling process as they acquire experience with it. The well-documented bundling strategies should also include the impact of the bundling

quantified. Such documents help STAs reduce concern over the major challenges faced during bundling.

The report shows that the majority of the STAs were concerned over the lesser participation of the smaller contractors, which may result in lesser competition and higher bidding prices. The authors recommend that the bundle size should be decided in such a way that would not exceed the capacity of the smaller contractors that might be qualified for the contract. Another approach to reduce this concern of STAs can be limiting the spatial proximity of the bundled projects.

The majority of the STAs, in the study, perceive that the risk of delaying the bundled contract due to the complication in one project might occur in a bundled contract while other components are ready. The study recommends STAs perform a detailed assessment of right of way (ROW), utility relocations, environmental permits, traffic detours, geographical locations, and construction staging to reduce such risks. Another key step to minimize the risks by STAs is to maintain regular communication between stakeholders.

The study, thus, provides the current state of the practice of the project bundling on various types of projects. The report also provides the challenges, concerns, and various risks associated with the bundling as perceived by various STAs that participated in the study. This will help provide an ample amount of knowledge and a unique perspective to agencies who are willing to implement the project bundling method. However, the study has some limitations. Although the questionnaire and invitation to participate in the survey were forwarded to all the fifty STAs in the U.S., not all the representatives from the agencies were contacted.

Another limitation of the study is that the results of this study were obtained based on the opinion of the representatives. Further case studies should be performed such that cross-validation of the results can be obtained by interviewing representatives from STAs as well as other public agencies. The majority of the STAs had experience in bundling similar types of projects. In the future, the researchers can examine whether STAs can gain similar or even greater efficiency from having different types of projects bundled together. The utilization of the Progressive Design Build (PDB) delivery method in bundled projects is at its initial stage. The effects of utilizing different project delivery methods in bundled contracts can be studied in the future, including PDB.

REFERENCES

[1] US Department of Transportation Federal Highway Administration (FHWA). *EDC-5, Project Bundling: A Strategic Program Delivery Solution that Saves Bundles*. https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/project-bundling-webinars-resource.pdf . Accessed February 14, 2022.

[2] U.S. House of Representatives. *Sec. 1111. Bundling of Bridge Projects, Section 1111 of Subtitle A of Title I (Federal Aid Highways), FAST Act Amendments to Section 144 of title 23, United States Code*. https://www.congress.gov/114/bills/hr22/BILLS-114hr22enr.pdf. Accessed February 9, 2020.

[3] Sanderson, V. Current Strategies to Address Increasing Highway Construction Costs and Reduced Competition. *Technical Agenda, AASHTO Subcommittee on Construction, Washington, DC*, 2006.

[4] Xiong, Y., J. D. Fricker, and S. Labi. Bundling or Grouping Pavement and Bridge Projects: Analysis and Strategies. *Transportation Research Record,* Vol. 2613, No. 1, 2017, pp. 37-44.

[5] Department of Defense. *Bundling Guidance*. https://business.defense.gov/Portals/57/Documents/Bundling%20Guidance.pdf?ver=2017-12-08-131415-820. Accessed May 27, 2020.

[6] UNFCCC. *Twenty-first Meeting of the Executive Board*. https://cdm.unfccc.int/EB/021/eb21repan21.pdf. Accessed May 27, 2020.

[7] AASHTO. *AASHTO COC Contract Administration Section Questionnaire Regarding Bundling*. https://construction.transportation.org/wp-content/uploads/sites/20/2018/05/Summary-of-responses-AASHTO-COC-CA-Questionnaire-Regarding-Bundling-03-22-2018.pdf. Accessed April 16, 2020.

[8] D'Angelo, D., B. Benton, T. Bishop, R. Garcia, and K. Atkins. Bridge Bundling Guidebook. An Efficient and Effective Method for Maintaining and Improving Bridge Assets.In, 2019.

[9] Transportation Research Board, E. National Academies of Sciences, and Medicine. *Effective Delivery of Small-Scale Federal-Aid Projects*. The National Academies Press, Washington, DC, 2011.

[10] U.S. Department of Transportation Federal Highway Administration (FHWA). *Bundled Facilities Overview*. https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/. Accessed February 20, 2020.

[11] Qiao, J. Y., J. D. Fricker, and S. Labi. Capital Program Cost Optimization Through Contract Aggregation Process.In, Purdue University. Joint Transportation Research Program, 2018.

[12] Heakal, R. *What are Economies of Scale?* https://www.investopedia.com/insights/what-are-economies-of-scale. Accessed February 10, 2020.

[13] Qiao, Y. J., J. D. Fricker, S. Labi, and T. Mills. Bundling bridge and other highway projects: Patterns and policies. *Transportation Research Record,* Vol. 2672, No. 12, 2018, pp. 167-178.

[14] Qiao, Y., J. D. Fricker, and S. Labi. Influence of Project Bundling on Maintenance of Traffic Costs across Highway Project Types. *Journal of Construction Engineering and Management,* Vol. 145, No. 8, 2019, p. 05019010.

[15] ---. Effects of bundling policy on project cost under market uncertainty: A comparison across different highway project types. *Transportation Research Part A: Policy and Practice,* Vol. 130, 2019, pp. 606-625.

[16] Miralinaghi, M., A. Davatgari, S. E. Seilabi, and S. Labi. Contract bundling considerations in urban road project scheduling. *Computer‐Aided Civil and Infrastructure Engineering*, 2021.

[17] Damnjanovic, I., S. Anderson, A. Wimsatt, K. F. Reinschmidt, and D. Pandit. Evaluation of ways and procedures to reduce construction cost and increase competition.In, Texas Transportation Institute, 2009.

[18] United States Environmental Protection Agency (EPA). *Public Participation Guide: Process Planning*. https://www.epa.gov/international-cooperation/public-participation-guide-process-planning#main-content. Accessed May 27, 2020.

[19] Torres, V. C., M. M. Uddin, P. M. Goodrum, and K. R. Molenaar. Mapping of Practices of State Transportation Agencies for Consultant Oversight of Construction Engineering and Inspection Services. *Transportation Research Record,* Vol. 2504, No. 1, 2015, pp. 28-38.
[20] Newman, R. B. *Use of consultants for construction engineering and inspection*. 1989.
[21] Wight, R., A. Alvarado, M. Chaput, D. Clayton, R. R. Garcia, D. Hoyne, J. Lewis, R. A. Lutz, and R. Smith. Developing And Maintaining Construction Inspection Competence.In, 2017.
[22] Pangburn, D. D. The Impact of Contract Bundling and Variable-Quantity Contracts on Competition and Small Business. *Pub. Cont. LJ,* Vol. 25, 1995, p. 69.
[23] AASHTO. *FHWA Disburses $225M in Competitive Highway Bridge Program Grants*. https://aashtojournal.org/2019/08/30/fhwa-disburses-225m-in-competitive-highway-bridge-program-grants/. Accessed March 15, 2020.
[24] Federal Highway Administration (FHWA). *Project Bundling: A Strategic Program Delivery Solution that Saves Bundles*. https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/project-bundling-webinars-resource.pdf . Accessed November 24, 2020.
[25] Yin, R. K. *Case study research: Design and methods*. sage, 2009.
[26] Hilal, A. H., and S. S. Alabri. Using NVivo for data analysis in qualitative research. *International interdisciplinary journal of education,* Vol. 2, No. 2, 2013, pp. 181-186.
[27] US Department of Transportation Federal Highway Administration (FHWA). *Bundled Facilities Overview*. https://www.fhwa.dot.gov/ipd/alternative_project_delivery/defined/bundled_facilities/. Accessed February 20, 2020.
[28] Oklahoma Department of Transportation. *Contracts and Proposals*. https://www.odot.org/contracts/index.htm. Accessed October 10, 2021.
[29] IOWA Department of Transportation. *Innovative Contracting Methods: Instructional Memorandums*. https://www.iowadot.gov/local_systems/publications/im/3730.pdf. Accessed September 10, 2021.
[30] D'Angelo, D., B. Benton, T. Bishop, R. Garcia, and K. Atkins. Bridge Bundling Guidebook an Efficient and Effective Method for Maintaining and Improving Bridge Assets.In, United States. Federal Highway Administration. Office of Policy …, 2019.
[31] Qiao, Y. J., J. D. Fricker, S. Labi, and T. Mills. Bundling Bridge and Other Highway Projects: Patterns and Policies. *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 2672, No. 12, 2018, pp. 167-178.
[32] Gransberg, D. Advanced Project Bundling: Risk Management Guide 1 ADVANCED PROJECT BUNDLING Risk Management Advanced Project Bundling: Risk Management Guide 2. 2020.
[33] Colorado Department of Transportation. *Risk Management*. https://www.codot.gov/business/project-management/scoping/risk-management. Accessed October 14, 2021.
[34] Montana Department of Transportation. *Risk Management Guidelines: Managing Project Costs through Identification and Management of Risks.* https://www.mdt.mt.gov/other/webdata/external/cadd/report_templates_guidance/RISK_MANUAL_MDT_2016.pdf. Accessed August 16, 2021.
[35] State of Michigan. *Governor Whitmer Announces Federal Grant for MDOT Bridge Bundling Program*. https://www.uppermichiganssource.com/2021/06/04/michigan-receives-federal-grant-to-expand-mdot-bridge-bundling-program/. Accessed November 1, 2021.
[36] Nebraska Department of Transportation. *Transportation Innovation Bridge Program*. https://dot.nebraska.gov/projects/tia/bridge-match/. Accessed November 1, 2021.
[37] Colorado Department of Transportation. *Statewide Bridge and Tunnel Enterprise*. https://www.codot.gov/programs/BridgeEnterprise. Accessed November 1, 2021.

APPENDICES

A.1 Phase I Study Questionnaire – State of the Practice Survey

Purpose:
The purpose of this survey is to gather the state of practice information about Project Bundling (PB) that will assist highway agencies to better implement a more advanced approach to PB. This advanced approach is applied consistently, strategically, and early in project programming to obtain maximum benefit for all project types, not just for bridges. This survey builds upon results from the 2018 AASHTO Committee on Construction survey.

Procedures:
The survey approximately takes about 10-15 minutes to complete. Please forward this survey to persons within your agency who are familiar with how you do PB. This survey consists of questions asking about your experiences in implementing the project bundling method in construction projects.

Risk of Participation:
There are no known risks associated with this project which are greater than those ordinarily encountered in daily life.

Benefits of Participation:
Your participation and responses are valuable to this case study. It will assist highway agencies to better implement a more advanced approach to PB.

Confidentiality:
Your responses will remain confidential and will only be published in an aggregated manner with other participants'. The records of this study will be kept private.

Compensation:
No compensation will be provided to the participants in this study. However, the analysis of the results of this study will be made available later to the participants.

Contacts:
Please contact the researchers at the following email address/phone number if you would like to discuss about the study or request information about the results of the study.

Dr. Yongwei Shan, Ph.D., P.E.
School of Civil and Environmental Engineering,
Oklahoma State University
Yongwei.shan@okstate.edu
(405) 744-7073

Saurav Shrestha
School of Civil and Environmental Engineering,
Oklahoma State University
saurav.shrestha@okstate.edu

If you would like to discuss any questions about the survey with someone independent of the research team, please contact:
Oklahoma State University Institutional Review Board (IRB)
irb@okstate.edu
(405)-744-3377.

Participants Rights:
I understand that my participation is voluntary, that there is no penalty for refusal to participate and that I am free to withdraw my consent and participation in this project at any time, without penalty.

Future Use of Information:
Your information might be distributed or used for future research studies without additional informed consent.

Consent Documentation:
I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits of my participation.

I affirm that I am 18 years of age or older. I have read and fully understand this consent form. I sign it freely and voluntarily. I hereby give permission for my participation in this study.

☐ Yes

☐ No

(If answered "Yes" in the previous question): Please enter your information (your information will be kept confidential)

Name:

Title:

Email:

Agency associated with:

1. Project Bundling is a contracting strategy where multiple projects are combined in a single project contract. Has your agency used this or similar contracting strategies before?

   ☐ Yes

   ☐ No

2. (*Applicable only if 'No' in Question 1*) What are the major reasons that your agency is not using this contracting method of bundling? Please select all that apply.

   ☐ Additional resources required

   ☐ Management of bundled projects get complicated

   ☐ Lack of champions

   ☐ Agency does not allow project bundling.

   ☐ Neccesity of multiple designers.

   ☐ Affects the consistency of the project.

   ☐ Federal-Aid Requirement

   Please specify other reasons, if any:

2. (*Applicable if 'Yes' in Question 1*) What level of experience does your agency have for project bundling?

   ☐ Just started implementing

   ☐ Have been using for a while but no formal process

   ☐ In the process of standardizing the bundling process and strategies

   ☐ Already have a standardized process and well documented strategies

   (If last option is selected, we will ask them to provide documents)

3. What categories of projects have you bundled so far (Please check all that apply)?

   ☐ Bridge Projects (Bridge preservation, rehablitation, and replacement)

   ☐ Roadway Projects (such as new road construction, added travel lanes, shoulder rehabilitation and repair, pavement resurfacing, intersection improvement, pavement repair, etc.)

   ☐ Traffic Operations (signals, intelligent traffic systems, etc.)

   ☐ Safety Projects (pedestrian safety projects, local and rural road safety projects such as guardrails, lighting, pavement marking, rumble strip installation, LED light installation, warning signs, etc.)

   ☐ Building Facility Projects (such as new building construction, building rehabilitation and repair, rest area construction, traffic control centers etc.)

   Other (Please specify):

4. Have you observed any differences in practices of bundling bridge projects vs. bundling non-bridge projects?

   ☐ Yes , please specify the differences

☐ No

5. At what phase of the project has your agency been using the practice of bundling? (Select all that apply)

   ☐ Planning

   ☐ Programming

   ☐ Design

   ☐ Procurement

   ☐ Construction

6. Has your agency ever assessed projects' suitability for bundling?

   ☐ Yes

   ☐ No

7. (*Applicable only if selected 'Yes' in Q6*) Please select at what stage of the project is the suitability assessed. (Select all that apply)

   ☐ Planning

   ☐ Programming

   ☐ Design

   ☐ Procurement

   ☐ Construction

8. Does your agency have a published method to determine which projects to bundle?

   ☐ Yes

   ☐ No

   8.a. You selected 'Yes' in Q8. If close at hand, please share your published method to determine which project to bundle.
   (*Upload Portal will be available in Qualtrics*)

9. How often are the following factors considered when selecting projects to be included in a bundle? (Please check all that apply)

Factors	Never	Rarely	Sometimes	Most of the time	Always
Contract size (in dollars)	☐	☐	☐	☐	☐
Number of projects in a bundle	☐	☐	☐	☐	☐
Project Type	☐	☐	☐	☐	☐
Work Type	☐	☐	☐	☐	☐
Spatial Proximity	☐	☐	☐	☐	☐
Factors	**Never**	**Rarely**	**Sometimes**	**Most of the time**	**Always**
Functional classes (Urban vs. Rural; Interstate vs Non-interstate)	☐	☐	☐	☐	☐
Traffic Volume	☐	☐	☐	☐	☐
Design Speed	☐	☐	☐	☐	☐
Letting Season	☐	☐	☐	☐	☐
Environmental Permitting Processes	☐	☐	☐	☐	☐
Factors	**Never**	**Rarely**	**Sometimes**	**Most of the time**	**Always**
ROW Acquisition	☐	☐	☐	☐	☐
Project Risks	☐	☐	☐	☐	☐
Providing economic stimulus via small and DBE contractors.	☐	☐	☐	☐	☐

Please specify other factors, if any:

10. Has your agency limited the maximum number of projects that can be bundled in a contract?

☐ Yes , please specify the limit and the reason for this limit

☐ No

11. In your opinion, what is the most effective contract size for a bundled project?

☐ Less than $1.0M

☐ $1.0M to $5.0M

☐ $5.0M to $10.0M

☐ Greater than $10.0M

☐ Depending on the project type

☐ Not Sure

Please specify other, if any: _____

12. What types of project delivery methods has your agency used for bundled contracts (Select all that apply)?

☐ Design-Bid-Build

☐ Indefinite Delivery and Indefinite Quantity (ID/IQ)

☐ Design Build

☐ Construction Manager/General Contractor (CM/GC)

☐ Public-Private Partnership

Please specify other, if any

13. Has your agency developed a published process to select the proper project delivery method for bundled projects?

☐ Yes

☐ No

If you answered 'Yes' in Q13. If close at hand, please share your published process. (*Upload Portal available at Qualtrics*)

14. Compared with the traditional contracting method, are the risk levels in the bundled projects the same as if individual projects would be contracted separately.

☐ Yes

☐ No , please specify the difference

15. The major advantages of project bundling are listed below. Based on your experience, please indicate how much you agree or disagree with each statement.

Major Advantages	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Reduces agency administrative costs.	☐	☐	☐	☐	☐
Reduces the cost of the individual projects in a bundle.	☐	☐	☐	☐	☐
Reduces project delivery time per project.	☐	☐	☐	☐	☐
Helps achieve economies of competition, meaning: higher number of bidders, and lower bidding prices.	☐	☐	☐	☐	☐
Improves the project quality	☐	☐	☐	☐	☐
Reduces change orders	☐	☐	☐	☐	☐
Affords the contractor flexibility in scheduling an individual project around other projects.	☐	☐	☐	☐	☐
Helps achieve asset management system performance goals (e.g. reduces fatalities and poor bridges, improves pavement smoothness).	☐	☐	☐	☐	☐

Please specify any other advantages, if not listed above:

16. Has your agency ever quantified the impact of project bundling on your projects compared to traditional contracting strategy?

☐ Yes

☐ No , please specify the reason:

17. For the potential bundling benefits listed below, please select the perceived percentage of savings or reduction.

Components	0-20 %	20-40 %	40-60 %	No Impact
Time savings	☐	☐	☐	☐
Cost Savings	☐	☐	☐	☐
Quality increased	☐	☐	☐	☐

Components	0-20 %	20-40 %	40-60 %	No Impact
Reduction in Change Orders	☐	☐	☐	☐

18. Among the following list of drawbacks or challenges associated with project bundling, how concerned is your agency about them?

Major Disadvantages	Not at all	Of little Concern	Moderately Concerned	Concerned	Very Concerned
It has been a challenge to track the funds separately due to accounting and funding system	☐	☐	☐	☐	☐
Ensuring adequate staffing levels at each site is challenging when multiple sites are relatively apart or working concurrently.	☐	☐	☐	☐	☐
It creates political pushbacks from local smaller contractors.	☐	☐	☐	☐	☐
Major Disadvantages	**Not at all**	**Of little Concern**	**Moderately Concerned**	**Concerned**	**Very Concerned**
Bundled roadway projects may eliminate the competition from smaller contractors, thus decreasing bidding competition.	☐	☐	☐	☐	☐
Multiple projects in a bundle may result in the involvement of several subcontractors resulting in construction inconsistency.	☐	☐	☐	☐	☐

Please specify any other disadvantages or challenges, if not listed above:

19. Have you received any feedback regarding project bundling from contractors?

☐ Yes , please specify:

☐ No

20. Would you mind sharing the request for proposal (RFP) of a typical bundling project?

☐ Yes

☐ No

If 'Yes' in Q20, please send the document to Yongwei Shan (Yongwei.shan@okstate.edu) or Saurav Shrestha (saurav.shrestha@okstate.edu).
[Upload portal will be available in Qualtrics]

21. Has your agency developed a guidebook for project bundling?
If yes, could you please share the document with us?

☐ Yes

☐ No

If ‘Yes’ in Q20, please send the document to Yongwei Shan (Yongwei.shan@okstate.edu) or Saurav Shrestha (saurav.shrestha@okstate.edu).
[Upload portal will be available in Qualtrics]

22. Would you be willing to be contacted by the research team later, if needed?

☐ Yes

☐ No

A.2 Phase II Study Questionnaire – Follow Up Interview and Case Study

Bundling Objectives and goals

1. What goals or objectives does your agency try to achieve through project bundling? (I bundle because……)
2. Have you seen any impact on the quality of the bundled project compared to non-bundled projects?

Decision to Bundle:

1. What is your general approach for project bundling with respect to different types of projects (bridge, and non-bridge project)? How do you decide what projects to bundle and when
2. What kind of assessment would you perform before bundling to assess the project's suitability for bundling? Does your agency have any specific tools developed?

Bundling: at different Phase of the Project

1. Have you had any situation where the projects that were bundled in the initial phase of the project later had to be unbundled or Vice-Versa?

Risk Management Before and During Bundling

1. Does your agency have a formal risk management program?
2. Have you observed any risks that happen to bundled projects more often than non-bundled projects?
3. How is risk management applied to the bundled projects?

Local Small Contractors/Agencies Involvement

1. Have you ever experienced any push back from local small contractors since the bundled projects might be large for small contractors to compete against the big ones?
2. What percentage of the project is subcontracted to local contractors?
3. How is the bundled contract prepared to involve equal participation of local contractors?

Funding

1. In general, what sources of funding are utilized in bundling projects?

Success/Challenges Story

1. Would you mind sharing with us a very successful bundling project that you had and bundle project that has a lot of challenges? What are the lessons learned from those projects? (Ask for more details regarding the project)

A.3 Qualtrics Survey Report

Q1 - Project Bundling is a contracting strategy where multiple projects are combined in a single project contract. Has your agency used this or similar contracting strategies before?

#	Answer	%	Count
1	Yes	97.14%	34
2	No	2.86%	1
	Total	100%	35

Q2 - What are the major reasons that your agency has not implemented this contracting method of bundling? (Select all that apply)

#	Answer	%	Count
1	Additional resources required	0.00%	0
2	Management of bundled projects gets complicate	0.00%	0
3	Lack of champions	0.00%	0
4	Agency does not allow project bundling	0.00%	0
5	Necessity of multiple designers	0.00%	0
6	Affects the consistency of the project	0.00%	0
7	Federal-Aid Requirements	0.00%	0
8	Please specify other reasons, if any:	100.00%	1
	Total	100%	1

Please specify other reasons, if any: - Text

Our agency tries to fragment larger jobs so that local contractors can have a chance to do them. Once a job becomes large, no one in the local market is competitive and the local contractors' association puts political pressure on us to fragment.

Q2 - What level of experience does your agency have for project bundling?

#	Answer	%	Count
1	Just started implementing	2.94%	1
2	Have been using for a while but no formal process	70.59%	24
3	In the process of standardizing the bundling process and strategies	17.65%	6
4	Already have a standardized process and well documented strategies	8.82%	3
	Total	100%	34

Q3 - What categories of projects have you bundled so far (Please check all that apply)?

#	Answer	%	Count
1	Bridge Projects (bridge preservation, rehabilitation and replacement projects)	29.63%	32
2	Roadway Projects (such as new road construction, added travel lanes, shoulder rehabilitation and repair, pavement resurfacing, pavement repair, etc.)	22.22%	24
3	Traffic Operations (signals, intelligent traffic systems, etc.)	20.37%	22
4	Safety Projects (highway safety improvement projects, local and rural road safety projects, roadway departure projects, intersection safety, pedestrian safety projects, etc.)	21.30%	23
5	Building Facility Projects (new building construction, building rehabilitation and repair, rest area construction, traffic control centers, etc.)	0.00%	0
6	Others (Please specify)	6.48%	7
	Total	100%	108

Others (Please specify) - Text
culvert replacement ADA ramps
The Department has for years carried out what it called “batch” solicitations, which have much in common with Project Bundling. The Division of Project Management creates single projects from numerous locations within a particular region where we plan to replace sign structures, or where we plan ADA improvements. These are designed in-house and let to a single contractor. We are just starting to conduct the type of bundling that this survey is referencing. We have completed the solicitation for a bundle of two bridge replacement projects and have selected a designer for the Preliminary Engineering and Final Design phases. We will award the bundled project to a single contractor.
Slide repair projects with like type work in the same geographical area. The same is true with pipe liner projects and large culvert/small structure type projects.
Simple Asphalt Overlays
Highway Safety Improvement Projects (such as Rumble strip installation, pavement marking etc.)
ADA curb ramp projects
- Rest area work. - Freeway lighting. - We are currently piloting a local agency bridge bundled project.

Q4 - Have you observed any differences in the practices of bundling bridge projects vs. bundling non-bridge projects?

#	Answer	%	Count
1	Yes, please specify the difference	26.47%	9
2	No	73.53%	25
	Total	100%	34

Yes, please specify the difference -
We use some of the same parameters for the batched ADA and Sign Structure projects as we have for our inaugural bridge replacement bundle: similar type of work, similar scope, and similar geographic location. But we use in-house design squads to design the ADA and Sign Structure batched projects.
typically can economy of scale, as well as attracting larger contractors do to increased contract value
Different scope, geographic distribution, risks, design life, maintenance scope and frequency. Ownership in the case of bridges is a difference for our local agency program pilot project.
Every bridge has its own unique needs, and in situations where bridges in the same bundled group are physically far apart from one another, logistical problems can emerge
Efficiencies in Contract Administration
Able to get better prices for the work compared to having multiple small projects.
i am referring to companion projects as bundling, in addition to bundling similar projects. Companion projects are usually in the same vicinity. Bundled projects are typically of the same vicinity and similar in type. Bridge bundles in particular should have similar design and type. Culverts should be bundled with culverts and bridges with bridges, unless there are other opportnities to take advantage of.
We have only done it using Design/Build procurement
We bundle road projects on Interstates and high volume roads only in the same corridor. For bridges we can expand this to a geographical area. We will not bundle either if the MOT gets to complicated.

Q5 - At what phase of the project has your agency been using the practice of bundling? (Select all that apply)

#	Answer	%	Count
1	Planning	13.58%	11
2	Programming	22.22%	18
3	Design	29.63%	24
4	Procurement	16.05%	13
5	Construction	18.52%	15
	Total	100%	81

Q6 - Has your agency ever assessed projects' suitability for bundling?

#	Answer	%	Count
1	Yes	70.59%	24
2	No	29.41%	10
	Total	100%	34

Q7 - Please select at what stage of the project is the suitability assessed. (Select all that apply)

#	Answer	%	Count
1	Planning	24.44%	11
2	Programming	26.67%	12
3	Design	31.11%	14
4	Procurement	6.67%	3
5	Construction	11.11%	5
	Total	**100%**	**45**

Q8 - Does your agency have a published method to determine which projects to bundle?

#	Answer	%	Count
1	Yes	2.94%	1
2	No	97.06%	33
	Total	**100%**	**34**

Q9 - How often are the following factors considered when selecting projects to be included in a bundle? (Please check all that apply)

#	Question	Never	N	Rarely	N	Sometimes	N	Most of the time	N	Always	N	Total
1	Contract size (in dollars)	0.00%	0	11.76%	4	26.47%	9	41.18%	14	20.59%	7	34
2	Number of projects in a bundle	5.88%	2	11.76%	4	29.41%	10	35.29%	12	17.65%	6	34
3	Project type	0.00%	0	0.00%	0	17.65%	6	35.29%	12	47.06%	16	34
4	Work type	0.00%	0	0.00%	0	20.59%	7	26.47%	9	52.94%	18	34
5	Spatial proximity	0.00%	0	0.00%	0	20.59%	7	29.41%	10	50.00%	17	34
6	Functional classes (Urban vs. Rural; Interstate vs. Non-Interstate)	2.94%	1	23.53%	8	47.06%	16	20.59%	7	5.88%	2	34
7	Traffic volume	17.65%	6	23.53%	8	38.24%	13	14.71%	5	5.88%	2	34
8	Design speed	23.53%	8	38.24%	13	23.53%	8	8.82%	3	5.88%	2	34
9	Letting season	8.82%	3	14.71%	5	47.06%	16	17.65%	6	11.76%	4	34
10	Environmental permitting processes	5.88%	2	20.59%	7	38.24%	13	23.53%	8	11.76%	4	34
11	ROW acquisition	11.76%	4	8.82%	3	26.47%	9	35.29%	12	17.65%	6	34
12	Project risks	2.94%	1	11.76%	4	23.53%	8	38.24%	13	23.53%	8	34
13	Providing economic stimulus via small and DBE contractors	20.59%	7	23.53%	8	41.18%	14	14.71%	5	0.00%	0	34

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Contract size (in dollars)	2.00	5.00	3.71	0.92	0.85	34
2	Number of projects in a bundle	1.00	5.00	3.47	1.09	1.19	34
3	Project type	3.00	5.00	4.29	0.75	0.56	34
4	Work type	3.00	5.00	4.32	0.79	0.63	34
5	Spatial proximity	3.00	5.00	4.29	0.79	0.62	34
6	Functional classes (Urban vs. Rural; Interstate vs.	1.00	5.00	3.03	0.89	0.79	34

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
	Non-Interstate)						
7	Traffic volume	1.00	5.00	2.68	1.10	1.22	34
8	Design speed	1.00	5.00	2.35	1.11	1.23	34
9	Letting season	1.00	5.00	3.09	1.07	1.14	34
10	Environmental permitting processes	1.00	5.00	3.15	1.06	1.13	34
11	ROW acquisition	1.00	5.00	3.38	1.21	1.47	34
12	Project risks	1.00	5.00	3.68	1.05	1.10	34
13	Providing economic stimulus via small and DBE contractors	1.00	4.00	2.50	0.98	0.96	34

Q9.a - Please specify other factors considered, if any:

Please specify other factors considered, if any:
We consider: Competition in the geographic area. Proper balance of work for large & small contractors Project staffing
We also look at areas that may have historically low competition.
Type of work and District
DBE/SBE sub-contractor opportunities are built into the contracts
Convenience to the Public- Don't impact same route with multiple projects at different times.
mileage, funding (e.g. federal or state)
Efficiency of delivery, complexity of scope/design, constructability / access, utility conflicts, project "readiness", stakeholder input.
Utility coordination; Amtrak coordination; Section 106 mitigation; other environmental permitting requirements including NEPA
When we did our Fast 14 project in 2011 we had a number of interstate bridge decks that were part of a paving project. When we opened the decks up we found them to be in much worst shape than anticipated. We then turned around and put out a DB project to deal with replacing the decks. We recently opened bids on another project similar to the Fast 14 called Acceler-8 where eight bridge decks will be replaced on the Massachusetts Turnpike. This project is being done in advance of another DB project to rebuild the interchange at I-90/I-495.
Complexity of the Maintenance of Traffic needed. The safety in bundling. We do not want to create very many locations with back of que issues.

Q10 - Has your agency limited the maximum number of projects that can be bundled in a contract?

#	Answer	%	Count
1	Yes, please specify the limit and the reason for this limit:	8.82%	3
2	No	91.18%	31
	Total	**100%**	**34**

Yes, please specify the limit and the reason for this limit: - Text
We are starting small, to gain experience with the bridge replacement bundle (two individual projects bundled into one). We will be starting another bridge replacement bundle in September, also just two projects bundled into one. Our batched ADA and Sign Structure projects typically involve dozens of locations per project.
Yes because at one time our system would not handle too many
geography contract value

Q11 - In your opinion, what is the most effective contract size for a bundled roadway project?

#	Answer	%	Count
1	Less than $1.0M	5.88%	2
2	$1.0M to $5.0M	23.53%	8
3	$5.0M to $10.0M	11.76%	4
4	Greater than $10.0M	11.76%	4
5	Not Sure	26.47%	9
6	Please specify other, if any:	20.59%	7
	Total	**100%**	**34**

Please specify other, if any: - Text
It depends on the type 5 - 10 mill for most types. Bridge and pavement projects could be larger.could be l
It depends. Cost doesn't necessarily dictate economy for contract bundling.
Depends on the variables in Q9.
I do not feel the $ amount can be the sole determinant of effectiveness. Gepgraphics, competition, and work type are also important determinants to the effectiveness
Depends on the project type. Our construction contracts for the existing and pending bridge replacement bundles will probably be in the $5-10 M range. Our Sign Structure batches are in the $10 M range, and our ADA batches are in the $1 M range.
Depends on the project type
It will depend on the project type and specifics.

Q12 - What type of project delivery methods has your agency used for bundled contracts? (Select all that apply)

#	Answer	%	Count
1	Design-Bid-Build	59.26%	32
2	Indefinite Delivery and Indefinite Quantity (ID/IQ)	7.41%	4
3	Design Build	25.93%	14
4	Construction Manager/General Contractor (CM/GC)	1.85%	1
5	Public-Private Partnership	3.70%	2
6	Please specify other, if any:	1.85%	1
	Total	**100%**	**54**

Please specify other, if any: - Text
South Dakota DOT is limited to Design-Bid-Build per codified law

Q13 - Has your agency developed a published process to select the proper project delivery method for bundled projects?

#	Answer	%	Count
1	Yes	5.88%	2
2	No	94.12%	32
	Total	**100%**	**34**

Q14 - Compared with the traditional contracting method, are the risk levels in the bundled projects the same as if individual projects would be contracted separately.

#	Answer	%	Count
1	Yes	73.53%	25
2	No, please specify the difference	26.47%	9
	Total	**100%**	**34**

No, please specify the difference - Text
Montana bridge projects usually include smaller bridges. What we have discovered though is that the project risk grows exponentially with the bundling.
We bundle projects for a few different reasons. Sometimes we bundle smaller projects such as patching hoping to get lower unit prices due to economies of scale. It also simplifies contract admin as we get one contractor who typically comes in and performs all of the work all at once rather than multiple contractors who perform the work at differing times. In this scenario risks are similar. We also bundle larger projects to insure project coordination occurs between all contractors by having one prime in charge of everything. The risk associated with this is that we sometimes get higher unit prices for some of the work because there is a cost to having subs answer to a prime. There are also many contract admin efficiencies gained by having one contract to administer and one prime coordinating all work to get the contract completed. In this scenario some risks are higher and some are lower.
Risks are generally the same. One inherent risk of a bundle is the possibility that one of the component projects of a bundle encounters delays in design and is not ready for construction authorization when the other components are. We manage that risk by assessing each project's needs -- before the bundle is assembled -- in terms of ROW, utility relocation, environmental permits, traffic detours and construction staging.
No differences
When two adjacent roadway projects are bundled, the risks associated with coordinating work between two separate contractors are removed.
Possibly. A single project has discrete risks which can be managed independently; multiple projects together present complexity and potentially compound the impacts (schedule delay, cost increase, reputation)
No, because with bundled projects, if one bridge in a bundle has issues that do not apply to the others in the bundle, then the whole contract may be impacted. In addition, with multiple locations to manage, inspection personnel have to spread out.
Depends on the bidding process - D-B or P3
Since we have only used DB procurement for these types of projects there is a higher level of risk on the contractor to meet schedule. We have included I/D clauses on each of the projects to make sure schedules are met.

#	Question	Strongly agree	N	Somewhat agree	N	Neither agree nor disagree	N	Somewhat disagree	N	Strongly disagree	N	Total
1	Reduces agency administrative costs.	35.29%	12	32.35%	11	17.65%	6	14.71%	5	0.00%	0	34
2	Reduces the cost of the individual projects in a bundle.	29.41%	10	55.88%	19	8.82%	3	5.88%	2	0.00%	0	34
3	Reduces project delivery time per project.	8.82%	3	44.12%	15	44.12%	15	2.94%	1	0.00%	0	34
4	Helps achieve economies of competition, meaning: higher number of bidders and lower bidding prices.	5.88%	2	52.94%	18	29.41%	10	8.82%	3	2.94%	1	34
5	Improves the project quality.	0.00%	0	17.65%	6	70.59%	24	11.76%	4	0.00%	0	34
6	Reduces change orders.	0.00%	0	8.82%	3	70.59%	24	17.65%	6	2.94%	1	34
7	Affords the contractor flexibility in scheduling an individual project around other projects.	20.59%	7	41.18%	14	35.29%	12	2.94%	1	0.00%	0	34
8	Helps achieve asset management system performance goals (e.g. reduces fatalities and poor bridges, improves pavement smoothness).	8.82%	3	32.35%	11	52.94%	18	5.88%	2	0.00%	0	34

Q15 - The major advantages of project bundling are listed below. Based on your experience, please indicate how much you agree or disagree with each statement.

Q15.a - Please specify any other advantages, if not listed above:

Please specify any other advantages, if not listed above:

We'd prefer to leave this section blank until we have data on the bridge replacement bundles. We expect to have interesting data because we solicited for design services for a single bridge replacement project at the same time we solicited for the bundle of two bridge replacement projects.

We are tracking durations and costs for both, through design and construction. All three of the bridges are of the same size, scope, and historical significance. They span the same Delaware & Raritan Canal. The one that is proceeding as an individual project was excluded from the bundle because it will require a different construction methodology due to different existing structural features.

We bundle in a effort to increase efficiency, both internally and externally, INDOT practices bundling to reduce customer impact, construction costs and internal manpower limitations.

The ability to mix asset treatment types to reduce inconvenience to the public and eliminate traffic interruptions; the ability to bundle assets with common problems, such as all amtrak bridges on a certain span of track

Depending on the proximity of the projects, bundling can reduce the impact to the traveling public by peforming the work in sequence or concurrently instead of having multiple separate traffic control setups and closures. Environmental permitting can be more at a programmatic level for all of the projects, with specific permits for each project. Similar designs creates opportunity for similar construction and efficiency in product delivery. Can order multiple pre-cast elements in some cases and install them quickly concurrently or in series with each project.

Q16 - Has your agency ever quantified the impact of project bundling of your projects compared to traditional contract strategy?

#	Answer	%	Count
1	Yes	17.65%	6
2	No (Please specify the reason)	82.35%	28
	Total	100%	34

No (Please specify the reason) -
We are just staring the process - and will visit this at a future date
Not that I am aware of.
No good way to compare bundled pricing vs non-bundled pricing.
Not sure why. Our bundled contracts have been relatively small so a comparison may not provide any useful information that is not already known!
Probably because of the small amount of bundling of projects that are undertaken.
Bundled projects were never identified and tracked for separately. We are working on doing this currently.
Not sure.
not sure
We have not undertaken this quantification yet.

Q17 - For the potential bundling benefits listed below, please select the perceived percentage of savings or reduction.

#	Question	0 - 20 %	N	20 - 40 %	N	40 - 60 %	N	No Impact	N	Total
1	Times Savings	61.76%	21	8.82%	3	2.94%	1	26.47%	9	34
2	Cost Savings	64.71%	22	23.53%	8	0.00%	0	11.76%	4	34
3	Quality Increased	26.47%	9	2.94%	1	0.00%	0	70.59%	24	34
4	Reduction in Change Orders	20.59%	7	5.88%	2	0.00%	0	73.53%	25	34

Q18 - Among the following list of drawbacks or challenges associated with project bundling, how concerned is your agency about them?

#	Question	Not at all	N	Of little concern	N	Moderately Concerned	N	Concerned	N	Very Concerned	N	Total
1	It has been a challenge to track the funds separately due to accounting and funding system.	41.18%	14	29.41%	10	20.59%	7	8.82%	3	0.00%	0	34
2	Ensuring adequate staffing levels at each site is challenging when multiple sites are relatively apart or working concurrently.	5.88%	2	38.24%	13	38.24%	13	14.71%	5	2.94%	1	34
3	Project bundling creates political push-back from local smaller contractors.	14.71%	5	26.47%	9	38.24%	13	17.65%	6	2.94%	1	34
4	Bundled projects may eliminate the competition from smaller contractors, thus decreasing bidding competition.	5.88%	2	23.53%	8	44.12%	15	23.53%	8	2.94%	1	34
5	Multiple projects in a bundle may result in the involvement of several subcontractors resulting in construction inconsistency.	14.71%	5	61.76%	21	20.59%	7	2.94%	1	0.00%	0	34

Q18.a - Please specify any other disadvantages or challenges, if not listed above:

Please specify any other disadvantages or challenges, if not listed above:

The criteria above depend highly on the procurement method: alternative contracting or traditional design-bid-build. The risk to the bidder is higher for alternative contracting, but several small contractors can partner up for larger projects. Not usually the case with traditional DBB.

Q19 - Have you heard any feedback regarding project bundling from contractors?

#	Answer	%	Count
1	Yes, please specify:	38.24%	13
2	No	61.76%	21
	Total	100%	34

Yes, please specify: - Text
Although we are just starting out with our program, we have heard that more out-of-state contractors are interested and encouraged that they can compete with the local companies.
Iowa has a lot of small to medium sized contractors. We get negative feedback when we bundle very large contracts in excess of $50 M because of the perception that it takes work away from the smaller contractors.
Concern that larger contracts may limit small contractors ability to bid due to bonding.
Some contractors express the desire to have more bundling. Some express less. We do not get consist feedback one way or the other. This is usually dependent on size of contractor.
Smaller contractors have expressed concern that bundling large projects may exclude them from bidding.
Some concern from DBE’s
Feedback has varied with the type of projects bundled.
Contractors like additional bidding opportunities provided by multiple projects. Also, if bundled projects are too large, they may not be a good fit for small or medium sized companies.
Contractors have noted that physical proximity is a priority for managing bundled projects to reduce the number of staging areas.
Depending on the procurement method and the attitude of the parties involved, there are many pros and cons to manage. It is better to bundle similar projects in close proximity, but we have bundled many bridges across 3 districts.
Contractors like the fact we are using the DB procurement because they feel they have more input in the overall process. Consultants do not like working directly for contractors. They would rather be under contract directly with DOT. Contractors treat designers like any other subcontractor and hold them responsible for items the consultants don't feel are their responsibility.
Mostly early on when we are trying different types of bundles and were not as concerned with geographical area, type of work bundles, time setting of bundled contracts and how to deal with

lumpsum items across several projects in the bundles. We have improved how we bundle contracts and concerns have now been more on time setting and payments.
They like it

Q20 - Would you be willing to share the request for proposal (RFP) of a typical bundling project?

#	Answer	%	Count
1	Yes	44.12%	15
2	No	55.88%	19
	Total	**100%**	**34**

Q21 - Has your agency developed a guidebook for project bundling?

#	Answer	%	Count
1	Yes	0.00%	0
2	No	100.00%	34
	Total	**100%**	**34**

Q22 - Would you be willing to be contacted by the research team later, if needed?

#	Answer	%	Count
1	Yes	76.47%	26
2	No	23.53%	8
	Total	**100%**	**34**