Evaluation of the Local Bridge Improvement Assistance Program

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16. Abstract

In 2019, a pilot program was initiated by the Wisconsin Department of Transportation (WisDOT) in consultation with the Wisconsin County Highway Association (WCHA) to streamline the delivery and oversight of Low-Risk local bridge projects. The goal of this research project was to evaluate the Low-Risk bridge pilot program and make recommendations before its implementation on a larger scale. Expanded data on sixteen pilot projects and fifty control projects were obtained and analyzed. The objective of this research project was achieved through:

1) a qualitative approach: a survey of local sponsors and stakeholders about the pilot project.

2) a quantitative approach: data analysis using a data-driven statistical approach involving analysis of pilot and control group data, and an evaluation of the performance metrics developed by WisDOT.

Detailed analyses comparing the pilot and control groups indicate that the pilot program provides statistically significant improvements with respect to budget and project costs. Furthermore, the pilot program also improves (reduces) the project schedule but at a reduced level of statistical significance. Finally, the pilot program's influence on project quality is not conclusive. These results are further confirmed and supported through an assessment of WisDOT's own performance metrics for the pilot program.

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Final Report

Evaluation of the Local Bridge Improvement Assistance Program

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EXECUTIVE SUMMARY

In 2019, a pilot program was initiated by the Wisconsin Department of Transportation (WisDOT) in consultation with the Wisconsin County Highway Association (WCHA) to streamline the delivery and oversight of Low-Risk local bridge projects. The goal of this research project was to evaluate the Low-Risk bridge pilot program and make recommendations before its implementation on a larger scale. Expanded data on sixteen pilot projects and fifty control projects were obtained and analyzed. The objective of this research project was achieved through:

1) a qualitative approach: a survey of local sponsors and stakeholders about the pilot project.

2) a quantitative approach: data analysis using a data-driven statistical approach involving analysis of pilot and control group data, and an evaluation of the performance metrics developed by WisDOT.

Detailed analyses of data comparing the pilot and control groups indicate that the pilot program provides statistically significant improvements with respect to budget and project costs. Furthermore, the pilot program also improves (reduces) the project schedule but at a reduced level of statistical significance. Finally, the pilot program's influence on project quality is not conclusive. These results are further confirmed and supported through an assessment of WisDOT's own performance metrics for the pilot program.

Survey results show that most respondents believed that the pilot program could maintain or lower project costs, which is consistent with the results from the data analyses. Survey results also show that a slight majority of respondents believed that the pilot program could maintain or lower the time that it takes to complete a project. Survey results do not indicate a consensus on the pilot program's impact on project quality.

The research team recommends training programs for both WisDOT and the local government staff. This training should be focused on three aspects.

First, the goals of the program and ways to successfully implement them should be clarified.

Second, the reduced oversight requirements of the Low-Risk pilot program (when compared with the traditional projects) should be understood by all, and the expectations from all sides should be clarified.

Third, staff from the local governments who want to participate in the program should be trained to meet a minimum set of technical qualifications.

The research team further recommends modifications to some of the WisDOT's performance measures related to project quality metrics as outlined in the report. Moreover, additional efforts are recommended to improve areas with low-performance measures.

PROJECT BACKGROUND & OVERVIEW

To streamline the delivery and oversight of Low-Risk local bridge projects, a pilot program was initiated in 2019 by the Wisconsin Department of Transportation (WisDOT) in consultation with the Wisconsin County Highway Association (WCHA). WisDOT aimed to achieve improvements in its local bridge program, with a focus on cost, schedule, and quality. The pilot projects attempted to achieve improvements by delegating some project tasks and responsibilities to the local governments while maintaining overall management and oversight by WisDOT. This pilot program focused on Low-Risk local bridge projects that would be expected to have little or no real estate, utility, railroad, or environmental issues. Before the pilot program is implemented on a program level, an assessment is required to evaluate its effectiveness. Therefore, WisDOT initiated an evaluation of the Low-Risk pilot program to assess the impact of delegating certain project tasks to the local government units, and to understand how that delegation impacted project cost, schedule, and quality.

The overall goal of the research project described in this report was to evaluate the Low-Risk bridge pilot program and make recommendations to WisDOT before implementation on a program level. This goal was achieved by 1) collecting and analyzing data from pilot projects and control projects, and 2) conducting a survey of local sponsors and stakeholders on their impressions of the pilot project. The work is completed within the scope of the following five tasks.

Task 1. Obtain available data on the sixteen bridges in the pilot program (pilot set) as well as a set of similar bridges from outside of the pilot program (control set).

Task 2. Review, confirm and enhance the performance metrics developed by the department related to cost savings, time savings, design and document quality, construction quality, and construction changes.

Task 3. Conduct a survey of local sponsors and stakeholders to get their feedback on the pilot projects.

Task 4. Analyze all project data and survey information obtained, identify problems, and make recommendations

Task 5. Provide all required reports.

The remainder of this report will summarize details of the tasks completed and the related findings.

DATA COLLECTION & PREPARATION

The data collection and preparation efforts were conducted under project tasks 1 and 2. Available data on sixty-six bridge projects were collected, including sixteen bridge projects from the pilot program (pilot group); and fifty bridge projects from the control group. All pilot and control projects were selected by WisDOT. Control projects were determined based on similarity to the pilot projects. Lists of the pilot and control projects are shown in Table 1 and Table 2, respectively.

The sixteen pilot projects were located in five WisDOT regions across Wisconsin: Northcentral, Northeast, Northwest, Southeast, and Southwest. The projects were started in 2020 and 2021. The control projects were located in each of the five WisDOT regions. Most projects started in 2020 and 2021, with the inclusion of a limited number of projects that started before 2020. A map showing the distribution of pilot and control bridge projects is shown in Appendix 1.

After the identification of pilot and control projects by WisDOT, the research team collected bridge information and data on the pilot program performance measures for these projects.

Table 1 List of Pilot Projects

Region	County	Design ID	Project Title	Let Date
NC	Marathon	9443-01-00	CTH Y Plover River Bridge	2020
NE	Outagamie	6500-03-00	Hickory Drive Bridge over Apple Creek	2020
		4665-01-00	CTH CC Apple Creek Bridge	2020
NW	Barron	8827-00-00	CTH D Bridge	2020
		8328-00-00	Doritty Creek Bridge	2020
		8333-00-00	Rock Creek Bridge	2020
		8317-00-00	Hay River Bridge	2020
	Burnett	8844-00-01	Clam River Bridge	2021
	Jackson	7027-00-00	Robinson Creek Bridge	2021
	Pierce	7894-03-03	Trimbelle River Bridge	2021
SE	Waukesha	2790-03-00	CTH I Bridge over Fox River	2021
		2718-20-00	Prairie Avenue Bridge over Fox River	2021
		2718-19-00	Madison Bridge over Fox River	2021
SW	Crawford	5329-00-00	Woodward Hollow CR Bridge	2021
	Dodge	3818-00-00	Butler Creek Bridge	2020
	Jefferson	3636-00-02	Deer Creek Bridge	2021

Table 2 List of Control Projects

Region	County	Design ID	Project Title	Let Date
NC	Forest	7176-00-00	Little Popple River Bridge	2019
	Green Lake	7852-00-00	Grand River Bridge	2021
	Langlade	8398-00-00	Springbrook Bridge	2020
	Marathon	8415-00-00	Little Eau Pleine River Bridge	2021
		8931-00-00	East Br Big Eau Pleine River Bridge	2021
	Shawano	6605-00-00	Red River Bridge	2021
	Waupaca	6686-00-00	South Br Little Wolf River Bridge	2022
NE	Brown	6832-11-00	CTH J Suamico River Br	2020
		9308-06-00	Park View Rd Devils River Bridge & Approaches	2020
		9517-04-01	County Line Rd Golden Creek Bridge & Approaches	2020
	Kewaunee	4378-07-00	Black Creek Bridge	2021
		4380-04-00	Rio Creek Bridge	2020
	Manitowoc	6501-06-00	Branch River Road Bridge	2022
	Marinette	6506-05-00	Tower Hill Road Little Peshtigo River Bridge	2019
	Outagamie	4310-01-00	Branch Apple Creek Bridge	2021
		2030-15-00	Toad Creek Bridge	2021
NW	Clark	2160-17-00	E Fk Halls Creek Bridge	2021
	Dunn	2160-18-00	Pine Creek Bridge	2021
	Polk	2365-07-00	Fox Creek Bridge	2021
		2370-04-00	Clam River Bridge	2021
	Trempealeau	2575-03-00	Br N Br Elk Creek Bridge	2021
SE	Kenosha	3625-00-02	13th Ave Pike River Bridge	2020
		5325-00-03	CTH E Over Pike River	2017
	Milwaukee	5721-00-05	Bridge Over STH 36	2022
		5728-00-03	Bridge Over STH 36	2022
		5758-00-03	Bridge Over UP RR	2021
		6217-00-02	Bridge Over CP RR	2021
		6217-00-07	Bridge Over Oak Creek	2021
		5336-00-03	West Villard Ave Br Over Lincoln Creek	2021
		5691-00-09	S Dana Ct Bridge Over Land	2021
		2100-00-00	S 35th Street Over KK River	2019
	Racine	2984-32-01	Hoods Creek Rd Bridge Over Hoods Creek	2019
		2984-51-00	Memorial Dr Bridge Over Root River	2017
	Walworth	2703-00-03	Mill St White River Bridge	2019
		2706-00-01	Hospital Rd Ore Creek Bridge	2019
		2745-00-01	CTH DD Bridge Over Sugar Creek	2018
	Washington	3831-00-01	N Wacker Dr Rubicon River Bridge	2020
		3849-00-02	CTH M Over Milwaukee River Bridge	2019
		3849-00-03	Kettleview Dr Kewaskum Creek Bridge	2019
	Waukesha	4824-00-03	Bridge Over Spring Creek	2022
		3840-01-00	CTH Q Br Over Oconomowoc River	2018
SW	Columbia	2703-00-01	Crawfish River Bridge	2021
		2751-00-00	Crawfish River Bridge	2021
	Crawford	3766-00-00	Br Johnson Valley Cr Br	2022
		9391-00-00	Byers Rd Richland Creek Bridge	2021
	Dane	9819-00-00	Koshkonong Creek Bridge	2022
		9286-05-00	Pleasant Valley Br Bridge	2021
	Grant	4508-08-00	Kieler Creek Bridge	2021
		4519-09-00	Borah Rd Borah Creek Bridge	2021
	Rock	9246-10-00	Marsh Creek Bridge	2021

Bridge Information

The research team utilized four categories of contributing information: 1) bridge characteristic information, 2) site, utilities, and environmental information, 3) highway design and construction information, and 4) traffic control and detours information. Table 3 shows details of the contributing data that were collected and assigned to each of the four categories. The research team collected all available information from the Highway Structures Information System (HSI) database, project proposal files, and design plans for both the pilot and control projects.

Table 3 Bridge Contributing Information

Category	Data Items
Bridge Characteristic Information	Bridge Length (ft) | Deck Width (ft) | Deck Area (sq ft) | Number of Spans | Span Length (or Max Span Length if more than one span) (ft) | Type of Bridge Superstructure | Bridge Approach Slab Used
Site, Utilities, and Environmental Information	Bridge over water, road, or railroad | Utilities on the bridge, or overhead utilities | Erosion control requirements | Environmental impact and restrictions due to fish, birds... | Army Corps of Engineers permit required | Hazardous materials
Highway Design and Construction Information	Type of project (replacement, or rehabilitation) | Type of pavement (asphalt, concrete, gravel...) | Design speed for roadway (mph) | Approach pavement length to be reconstructed (on both sides of the bridge) (ft)
Traffic Control and Detour Information	Road closure | ADT | Detour | Detour length (mile)

WisDOT Pilot Program Performance Measures

WisDOT has proposed three categories of performance metrics to evaluate the pilot program: 1) budget: project cost and project delivery, 2) schedule: design schedule, delivery schedule, and construction finals, and 3) quality: environmental document reviews, construction contract modifications, and communication of construction contract modifications. Table 4 shows details of the performance measures.

- *Budget.* In "project cost", the cost per square foot is calculated by using the low bid price for the project and the bridge deck area. In "project delivery", the total design delivery cost and the total construction delivery cost are calculated by adding the related consultant delivery cost, WisDOT oversight cost, and local government delivery cost for design and construction, respectively.
- *Schedule.* In "design schedule", the number of days from scheduled Plans, Specifications, and Estimates (PSE) at project initiation to the actual PSE delivery is recorded. In "delivery schedule", the "Design Delivery Time" is counted from the design notice to proceed date to the date that the contract was let. In "construction finals", the time between the substantial completion date and the date that all records and agreed quantities were submitted to WisDOT for review is compared against a 180-day threshold.
- *Quality.* The "environmental document reviews" tracks the number of environmental document reviews by WisDOT. "Construction contract modifications" reports the dollar value of construction contract modifications as a percentage of the construction bid cost. "Construction contract modifications-communications" assesses whether the number of construction contract modifications known to the Local Public Agency (LPA) equals the actual

number of construction contract modifications. WisDOT staff from the Bureau of Project Development helped the research team collect all these performance measure data related to budget, schedule, and quality.

Table 4 WisDOT Performance Measures

Category		Data Item & WisDOT's Criteria to be a Success
Budget	**#1 Project Cost**	Low Bid Price/Amount | Bridge Deck Sq Ft | Cost Per Sq Ft
		This measure will be considered a success if 75% or more of the Low Risk bridges cost less than the average of the Control Group for the appropriate improvement type.
	#2 Project Delivery	Consultant Design Delivery Cost | WisDOT Design Oversight Cost | Local Government Design Delivery Cost | Total Design Delivery Cost (Consultant + WisDOT + Local) | Consultant Construction Oversight Cost | WisDOT Construction Oversight Cost | Local Government Construction Oversight Cost | Total Construction Delivery Cost (Consultant + WisDOT + Local)
		This measure will be considered success if the majority of the Low Risk projects have delivery costs lower than the average delivery cost of the Control Group.
Schedule	**#1 Design Schedule**	Scheduled PSE Date at Initiation | Actual PSE Delivery Date | Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery
		This measure will be considered a success if i) The actual PSE delivery date is on or before the original PSE scheduled date for at least 75% of Low Risk projects, ii) The average number of days of delay for Low Risk program does not exceed the average number of days of the Control Group.
	#2 Delivery Schedule	Design Notice to Proceed Date | Let Date | "Design Delivery Time"
		This measure will be considered a success if 75% of the project design times in the Low Risk pilot are less than the average design delivery time of the Control Group.
	#3 Construction Finals	Substantial Completion Date | Date Records and Quantities Submitted to WisDOT for Review | Difference 180 Days or Less?
		This measure will be considered a success if 100% of projects complete the final process within 6 months.
Quality	**#1 Environmental Document Reviews**	# Environmental Document Reviews by WisDOT
		This measure will be considered a success if 75% of projects in the Low Risk pilot achieve the one review goal.
	#2 Construction Contract Modifications	Value of State-Funded Construction Contract Mods | Construction Bid Amount | Percentage
		Success is defined as: i) The majority of Low Risk projects have change order percentage less than average percentage of the Control Group, ii) The Change Order percentage for Low Risk program is less than 5%.
	#3 Construction Contract Modifications - Communication	# Notifications of Construction Contract Modifications Known to LPA | # Construction Contract Modifications | #s matched
		This measure is a success if the number of modification justifications received by the LPA matches the total number modifications on the project.

Also listed in Table 4 are the criteria recommended by WisDOT to determine if the pilot program was successful in each performance metric [1]. For example, Budget #1 ("project cost") "*will be considered a success if 75% or more of the Low-Risk bridges cost less than the average of the Control Group for the appropriate improvement type".*

To make project delivery cost more representative, the research team recommended normalizing delivery cost by deck area. Thus, two new performance metrics were added within the project delivery category: total design delivery cost per sq ft and total construction delivery cost per sq ft.

Through the joint efforts of WisDOT and the research team, most of the required data on the selected pilot projects and control projects were collected. On select projects, some data elements were missing either because the project was not completed prior to the writing of this report, or because an LPA response was not received regarding construction contract modifications. The missing data were not included in the analyses. A database of project information from the 16 pilot projects and 50 control projects was developed. Appendix A shows the database with a sample case.

SURVEY OF LOCAL SPONSORS AND STAKEHOLDERS

Under project Task 3, the research team conducted an online survey of various stakeholders about the Low-Risk bridge pilot program. In consultation with WisDOT, the research team compiled a list of stakeholders and knowledgeable individuals to be contacted for a survey. Surveyed individuals represented WisDOT staff, Wisconsin local government agencies, WCHA, consultants, contractors, and others who might have participated in (or have relevant knowledge of) the pilot program. Information on any similar program in the neighboring states was also sought and obtained when available.

The research team first sent out an online survey questionnaire using Qualtrics (See Appendix B for survey questions) with follow-up phone calls to obtain additional information based on the answers provided. We believed that this approach was more effective than a written questionnaire. The survey and subsequent phone calls (or online meetings) sought the opinions of the survey respondents regarding the pilot program and their assessments of the program and the performance metrics. The survey was intended to collect the respondents' feedback on project management communications and deliverables. We also sought information on any problem areas and suggestions for improvements.

Survey Results

Twenty responses to the online survey were received (out of 38 individuals contacted), and 7 out of the 20 respondents agreed to a follow-up phone call. The detailed survey results are discussed below.

Survey Respondent: Role, Project Involvement & Project Level of Knowledge (Q1-Q3)

Among the twenty respondents, nine were WisDOT project managers, five were county officials, one was a design engineer, and five belonged to the "Other" group. In the "Other" group, there were two project supervisors, one project engineer, one WCHA official, and one Local Program Manager (LPM).

The four WisDOT personnel in the "Other" group were combined with the nine WisDOT project managers. Therefore, there were thirteen WisDOT personnel (9 WisDOT project managers, 2 project supervisors, 1 project engineer, and 1 LPM), 5 county officials, 1 design engineer, and 1 "Other", who was a WCHA official. Figure 1 shows the roles of the survey respondents.

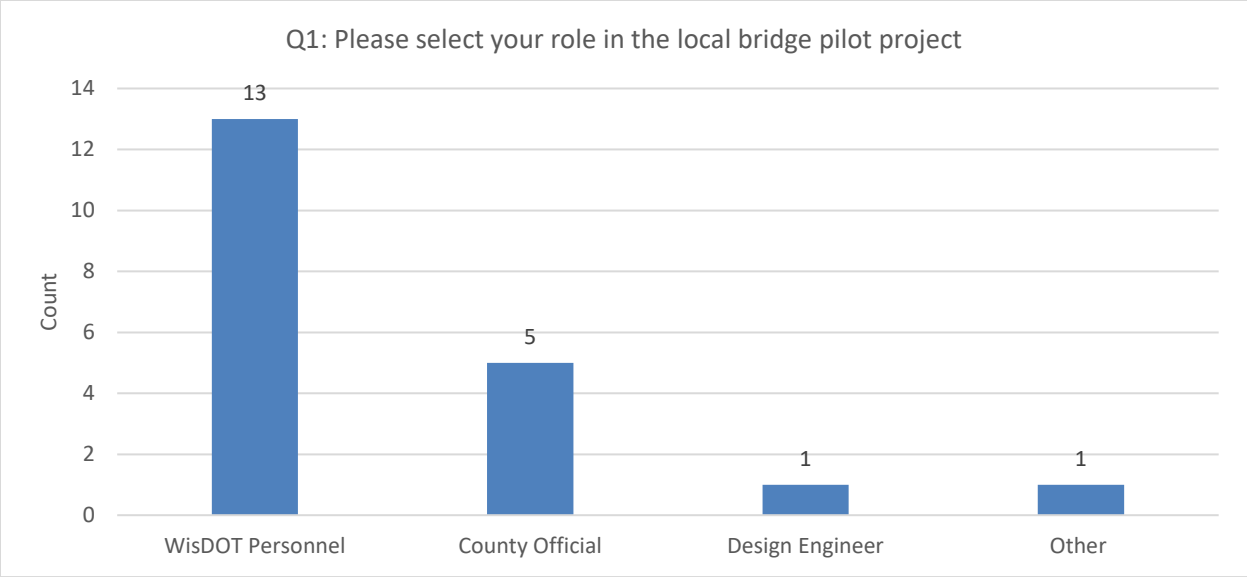

Figure 1 Respondents' role in the local bridge pilot program.

Of the twenty respondents, fifteen were involved in the development of the pilot program or knew about at least one project performed under the program. Regarding the knowledge and understanding of the pilot program, twelve selected "high", two selected "medium", and one selected "low". There was a strong correlation between project involvement and knowledge: the WisDOT respondents with "high" knowledge had all been involved in the pilot program. Figure 2 shows the knowledge distribution by role. Around 70% (9/13) of WisDOT personnel reported medium or above knowledge, and the corresponding rate for county officials was 80%. This ensures that the survey results convey knowledge-based information.

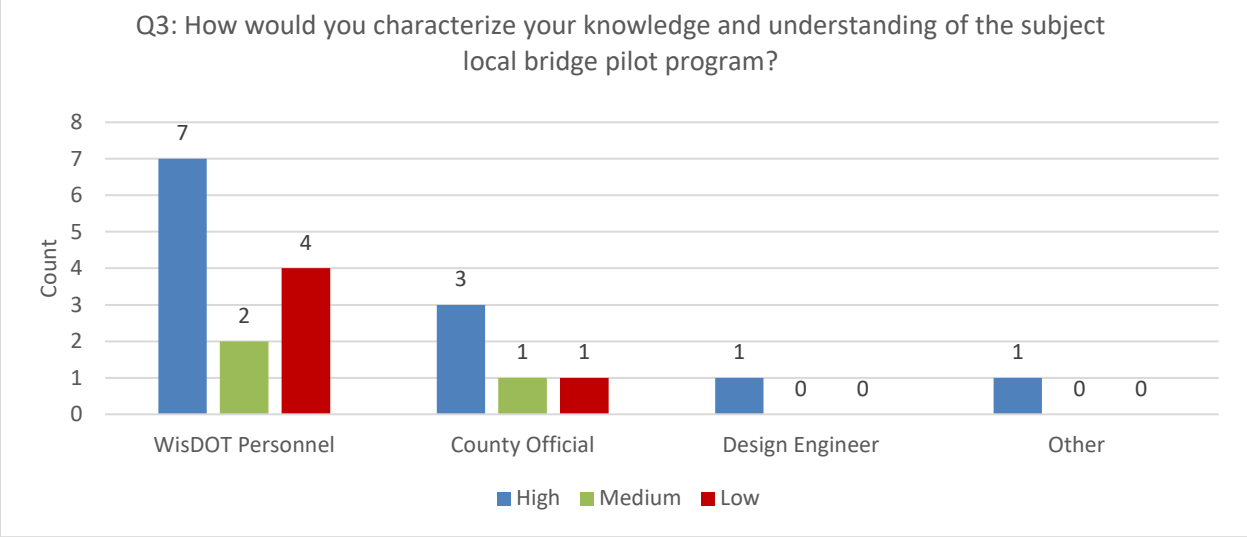

Figure 2 Respondents' knowledge of the pilot program by role.

Performance Measures: Budget, Schedule & Quality (Q4-Q6, Q9)

The three key performance measures – budget, schedule, and quality – were included in the survey. Regarding the project budget, four respondents thought that the pilot program had the potential to maintain the delivery cost (compared to the conventional approach), eight thought that it could lower the cost, while three believed that it could increase the cost. The five remaining respondents were not sure, four of whom believed that they had low knowledge of the pilot program. In short, regardless of the respondents' role, most considered that the pilot program could maintain or reduce the delivery cost (maintain/reduce vs increase:12 vs 3).

The research team also looked into the budget measure by role (Figure 3). Among WisDOT personnel, most saw the potential to maintain or reduce the cost while two thought that the program may increase the cost (maintain/reduce vs increase:7 vs 2). All county officials believed that the program could lower costs.

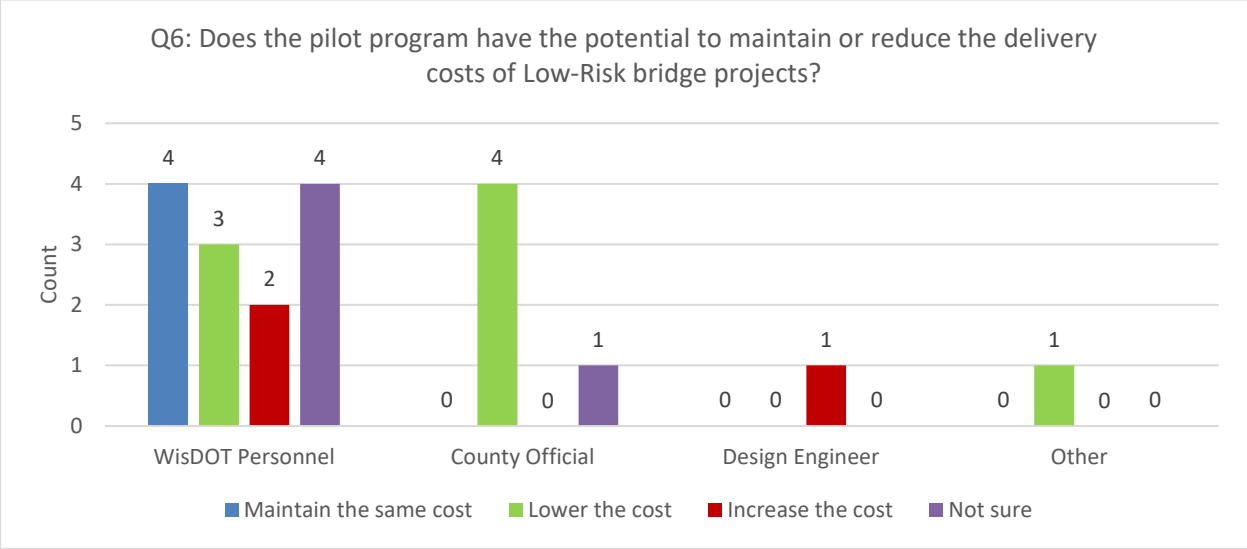

Figure 3 Performance measure of the pilot program by role - Budget.

For the project schedule, three respondents believed that the pilot program had the potential to maintain the project schedule (compared to the conventional approach), eight thought that it could accelerate the schedule; while five believed that it would delay the schedule. The remaining four respondents were not sure, all of whom had reported low knowledge of the pilot program. In short, regardless of the respondents' role, most believed that the pilot program could maintain or accelerate the schedule (maintain/accelerate vs delay:11 vs 5).

The research team also analyzed the schedule measure by role (Figure 4). Among WisDOT personnel, half thought that the program had the potential to maintain or accelerate the project schedule, while half thought that it could not (maintain/accelerate vs delay: 5 vs 5). In contrast, all county officials and the design engineer believed that the pilot program could accelerate the project schedule. In summary, there is a perception gap related to the impact of the pilot program on project schedule between WisDOT personnel and county officials.

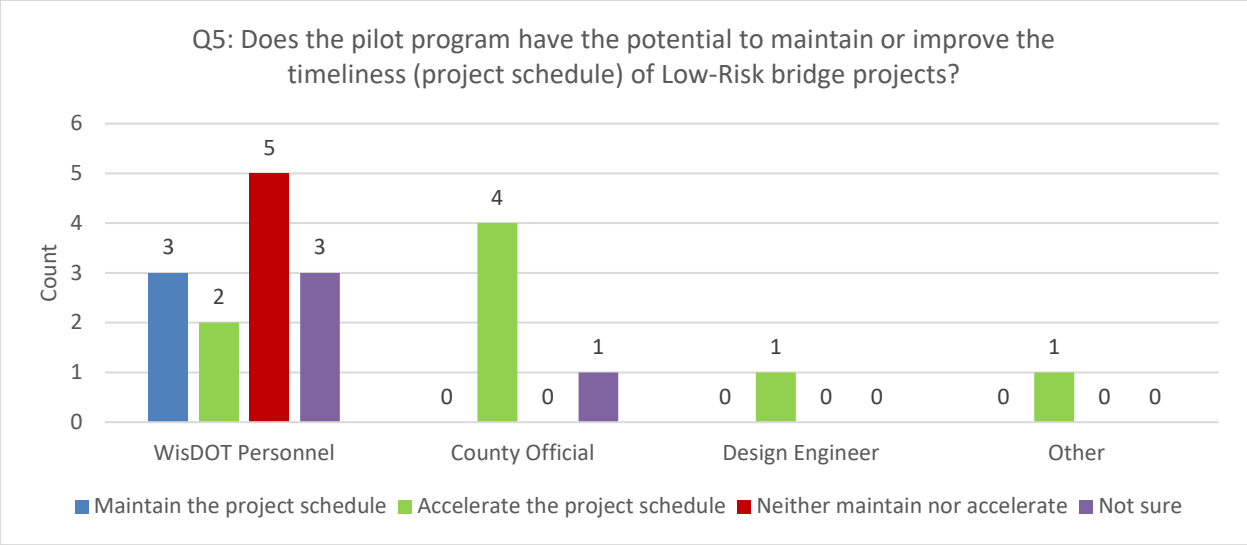

Figure 4 Performance measure of the pilot program by role - Schedule.

In terms of project quality, three respondents believed that the pilot program had the potential to maintain the project quality, five believed that it could improve quality; while eight believed that it would lower project quality. The rest (4 respondents) were not sure, all of whom had reported low knowledge of the pilot program. In short, regardless of the respondents' role, half thought that the pilot program could maintain or reduce the delivery cost, while the rest did not believe so (maintain/improve vs lower:8 vs 8).

The quality measure by role is shown in Figure 5. Most WisDOT personnel thought the pilot project lower project quality (maintain/improve vs lower: 3 vs 7). Most county officials believed that the program could improve project quality (maintain/improve vs lower:3 vs 1), while the design engineer thought that it could maintain project quality. Perceptions of project quality in the pilot program are therefore substantially different between WisDOT personnel and county officials.

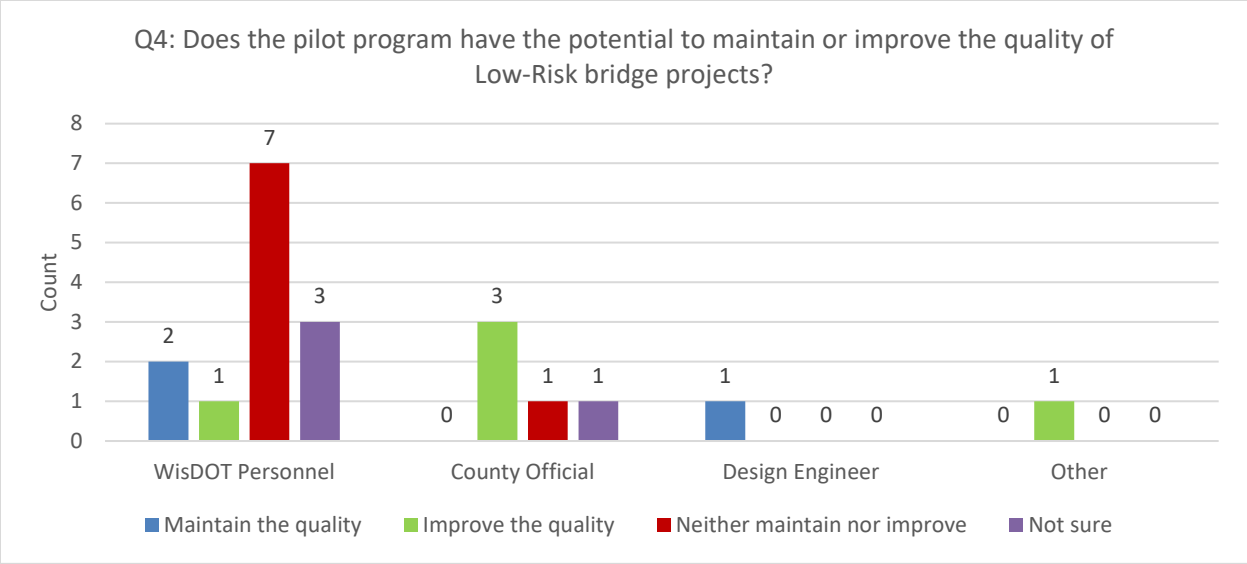

Figure 5 Performance measure of the pilot program by role - Quality.

Strengths & Weaknesses of the Pilot Program

In terms of the strengths of the pilot program, some WisDOT personnel did not see any major strengths, and they thought that their oversight efforts had increased. Other WisDOT personnel thought that the program "*provides a perception of expediting the project with streamlining responsibilities more to the locals for an active involvement*". In their view, the local sponsors could get more involved in the process and thus help WisDOT rebuild trust with local governments.

On the other hand, most county officials thought that the major strength of the program was in accelerating the project timelines and lowering the cost. One provided an example stating that the project "*went from signing the design contract to having the bridge totally constructed in 54 weeks, which is normally a 3-year process*". Another had their projects bundled, which reportedly resulted in better construction cost.

Regarding weaknesses, most WisDOT personnel saw more burden on WisDOT units including increased oversight responsibilities while not observing much time or cost savings. Another example of a weakness noted by WisDOT staff is that "*the program provides inconsistency in design documentation and confusion for all parties involved as to what is expected in design and construction.*" Another comment addressed preparedness of some local government agencies: "*determination of what qualified as a Low-Risk project did not take into consideration the capabilities of the project sponsor. A town that has a bridge project every 10 to 15 years is a high risk.*" Another WisDOT staff member expressed the opinion that the available guidance on the conduct of the pilot project and its differences from the traditional projects (with respect to project requirements) might not be known by all.

For some county officials, the major weakness was the participants' "*lack of the desire or initiative to make the program work*". Some believed that the local agencies needed constant attention to keep the project on track. They thought the program was hard for the local agencies, which were not familiar with the program unless they had experience with it. Others thought that WisDOT needs to place more trust in the local agencies and delegate more responsibilities to them.

Furthermore, "*ensuring uniform and comprehensive education to the Local program project sponsors, consultants, and WisDOT local program managers*" was viewed as a needed improvement.

Continuation of the Pilot Program

When asked "Considering the goals of the pilot program (streamlined delivery through increased delegation of tasks to local authorities) and your impression of how the pilot program is performing, should the current pilot program become permanent?", eleven respondents chose "Yes" while nine responded "No". Half of the respondents supported continuing the pilot program. However, large differences existed between the perceptions of WisDOT personnel and county official on this question (Figure 6**Error! Reference source not found.**). Five WisDOT respondents favored a permanent program while eight other WisDOT respondents did not. However, all five county officials supported the idea of making the pilot program permanent.

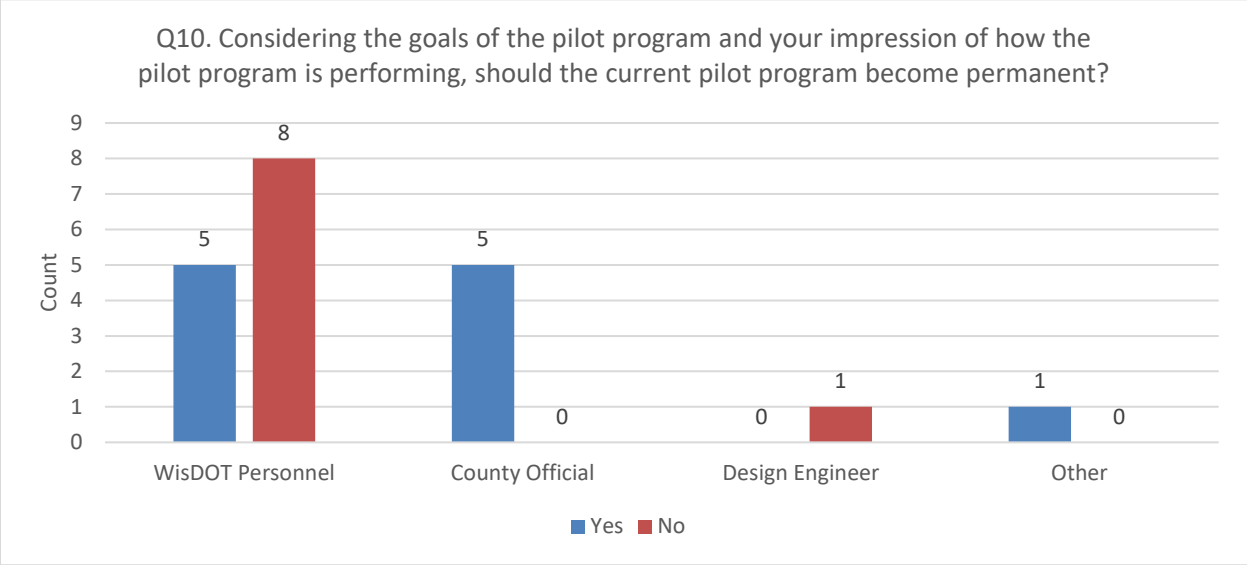

Figure 6 Should the current pilot program become permanent?

One WisDOT staff member who supported a permanent program wrote that "*the locals should fully embrace their role and actively participate in it*". It was further stated that the program "*must be limited to smaller, less complex structures*". Another respondent noted that "*some degree of education to the Local Sponsors needs to occur in order to be in the program*". Those WisDOT personnel who opposed the program did not believe that the processes were improved, or money/time was saved. One WisDOT respondent noted that "*this program will not be successful until the local sponsors can provide the staffing resources that are required to fulfill their responsibilities*". Another noted that "*the theory of the pilot could potentially be made permanent*", but "*the results of the pilot so far are skewed enough so there isn't an accurate picture of the pilot's long-term feasibility.*"

Some county officials supported the program because they believed that they had success with the pilot program. One respondent stated that "*there is no need to have redundant layers of oversight.*"

Another noted that, in case the program became permanent, "*more information should be given on how smaller and inexperienced municipalities can get involved.*"

Delegation of additional tasks

When asked "should any other project delivery tasks (or other project types) be delegated to local authorities for the sake of improvement in project delivery?", nine respondents chose "yes" while ten responded "no". WisDOT personnel and county officials had widely differing perceptions on this subject (Figure 7). Most WisDOT personnel were against more delegation of tasks (3 "Yes" vs 9 "No") while most county officials supported it (4 "Yes" vs 1 "No").

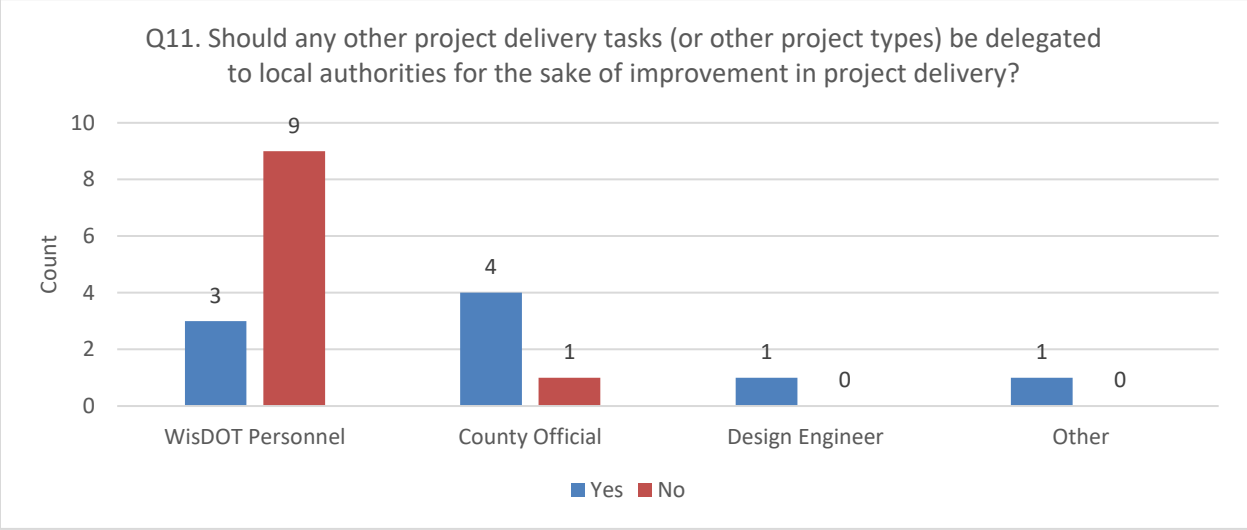

Figure 7 Should any other project delivery tasks be delegated to local authorities?

Those WisDOT staff members who supported more delegation of tasks thought that the project types included under the program should be simple bridges, and training should be offered for the benefit of local agency personnel. One WisDOT respondent who opposed further delegation of tasks stated: "*our locals do not have the resources or knowledge to take on more responsibility*". Another thought that most tasks could be delegated to the locals only if they took on responsibility for the outcome rather than WisDOT.

One of the county officials who backed more delegation of tasks stated that "*WisDOT should set the requirements and get out of the way allowing the locals and their consultant to complete the project*". Another respondent commented: "*given the success of the LRIP-S program, funding provided with a minimal amount of DOT oversight is clearly the best solution to maximizing the buying power of money.*" The only county official who opposed more delegation of tasks stated that "*it is hard for small departments to take on the additional responsibilities that come with these programs. Most don't have the time or expertise to complete the tasks needed.*"

Practices From Neighboring States

Information on similar programs in the neighboring states (e.g., Iowa, and Illinois) was sought through a search of online information about similar programs in neighboring states including, but not limited to, project reports and related web pages. Although no similar state aid project delivery programs for local bridges were found, useful practices regarding state DOTs' delegation of responsibilities to the local agencies have been noted. Iowa DOT has adopted innovative contracting methods such as combined projects for LPA [2]. LPA would be responsible for the administration and inspection of the construction contract. Illinois DOT has similar programs involving innovative project delivery and bridge bundling feasibility analysis [3].

Overall Survey Observations & Recommendations

The survey findings are summarized as follows based on the survey results.

- *Impact on cost, project schedule, and quality.* Most respondents believed that the pilot program had the potential to keep project costs low. A slight majority of respondents believed that the pilot program had the potential to maintain or reduce project schedule. There was no consensus on the impact of the program on project quality.

- *Workload redistribution.* A few WisDOT personnel had expected that the pilot program would reduce their workload, which they believe was not realized. The stated goals of the pilot program were focused on cost (including project, design, delivery, and oversight costs), project time, and project quality. The redistribution of the workload to the local governments might be viewed as an expected benefit of the pilot program but it is not a primary goal of the program.

- *Perception gaps.* WisDOT and local government personnel viewed the pilot program with differing expectations. Communication issues and project understanding issues were noted among the two groups. There is a clear need to provide training to address and clarify the goals of the program and ways to successfully achieve them. Each stakeholder's tasks and responsibilities should be clearly understood by all parties.

- *Lack of clarity and consistent expectations of the pilot program.* For Low-Risk bridge projects, some WisDOT personnel might not be fully aware of the reduced project requirements, while some local government personnel might not be familiar with all the requirements and steps required for a successful implementation. Different training programs are needed for both WisDOT and local government personnel. This training should clarify the goals and requirements of the Low-Risk pilot program and delineate the responsibilities and expectations for all sides.

- *Disparity in experience and technical knowledge of project requirements.* Inconsistent technical capabilities and knowledge of the project requirements among local governments create large disparities in program delivery. Some local governments have experienced personnel available while others may not have the in-house staff to address all technical and

managerial aspects. A continuation or expansion of the Low-Risk bridge program should be designed to ensure that the local governments interested in participating in the program receive sufficient training to manage such a program. An appropriate training program should be made available to local governments which are interested in the Low-Risk bridge projects. The local governments should be required to demonstrate that they have staff with the required knowledge of the project requirements and sufficient capability in the management of such projects. In case such qualifications are not established in advance, one option may be for the local government agency to submit the project to the Low-Risk program after completing the preliminary (30%) plans on its own to demonstrate its capabilities.

The survey results indicate that the Low-Risk pilot program was considered beneficial and useful by most respondents. Some adjustments can be made to further enhance the acceptance and success of the program.

DATA ANALYSIS & RESULTS

After performing a qualitative evaluation of the pilot program through the survey, the research team conducted a quantitative assessment (Task 4) using the collected data items and performance metrics for the selected pilot and control projects. First, descriptive statistics and statistical comparisons were performed on available data for the pilot and control groups. This is designed to show whether the contributing data from the two groups are significantly different and to assess whether the performance metrics from the two groups are comparable. Then, the performance metrics of the pilot group were evaluated by comparing them to the control group. The statistical comparison shows whether the performance metrics of the pilot projects are improved (with respect to the control group) in a statistically significant manner. Finally, the pilot program was evaluated using the performance criteria developed by WisDOT. The data-driven statistical methods and WisDOT's performance criteria are complementary in the process of evaluating the pilot program.

Analysis #1: Full Data

All data from the 16 pilot projects and 50 control projects was analyzed. Descriptive statistics (mean value, standard error, minimum value, maximum value, and count) of the contributing data items (continuous variables) are shown in Table 5. The standard error shows how different a population mean is likely to be from a sample mean of the available data. A larger standard error indicates a larger likelihood that the sample mean doesn't truly represent the population mean. For example, in the pilot group, bridge length has a mean value of 57.53 ft, a standard error of 7.54 ft, a minimum value of 32.50 ft, and a maximum value of 122.10 ft. On the other hand, in the control group, the bridge length has a mean value of 74.41 ft, a standard error of 8.27 ft, a minimum value of 23.00 ft, and a maximum value of 254.80 ft. Other descriptive statistics for the data items such as deck width, deck area, span length, design speed, approach pavement length, ADT, and detour length can also be found in Table 5.

Bridge length and deck area have noticeably larger values in the control group, which means that longer bridges exist in the control group. To measure if the difference between the two groups is statistically significant, the research team used a t-test to compare the continuous bridge data items including bridge length and deck area. A t-test is a statistical test that is used to compare the means of two groups with continuous variables. T-test results are shown in Table 5. When the p-value (one-tail) is less than 0.05, the difference is considered statistically significant. From the table, we can see that the difference in deck area (between pilot and control groups) is statistically significant (p-value =0.03), while the difference in bridge length is close to statistically significant (p-value =0.07). The differences in other contributing data items are not statistically significant except for the detour length (p-value is close to zero).

Table 5 Statistical Analysis on Contributing Data Items - Full Data

		Bridge Length (ft)	Deck Width (ft)	Deck Area (sqft)	Span Length (ft)	Design speed (mph)	Approach pavement length (ft)	ADT	Detour length (mile)
Pilot Group (16)	Mean	57.53	35.09	2086.25	44.71	45.00	144.10	1750.56	6.60
	Standard Error	7.54	2.99	332.25	3.11	2.37	26.78	826.33	1.45
	Minimum	32.50	26.50	861.00	30.00	30.00	0.00	22.00	1.00
	Maximum	122.10	67.00	4395.00	66.50	55.00	405.80	11400.00	16.00
	Count	16	16	16	16	16	16	16	10
Control Group (50)	Mean	74.41	38.18	3312.13	47.84	41.33	186.02	2453.98	9.22
	Standard Error	8.27	2.35	539.82	3.45	1.55	17.00	572.95	3.77
	Minimum	23.00	22.70	767.00	10.70	25.00	56.00	10.00	1.00
	Maximum	254.80	102.00	14268.00	127.00	60.00	560.00	14100.00	124.00
	Count	47	48	47	48	45	43	46	45
t-test	t Stat	-1.51	-0.81	-1.93	-0.67	1.29	-1.32	-0.70	-4.27
	P(T<=t) one-tail	0.07	0.21	0.03	0.25	0.10	0.10	0.24	0.00
	t Critical one-tail	1.68	1.69	1.67	1.68	1.70	1.70	1.70	1.68

Descriptive statistics of the categorical contributing data items were also generated. Regarding the number of spans, there are thirteen single-span bridges and three 2-span bridges in the pilot group; while in the control group, there are thirty-five single-span bridges, seven 2-span bridges, and eight 3-span bridges. For the type of bridge superstructure, there are two bridges with prestressed concrete girder, ten bridges with concrete flat slab, three bridges with continuous prestressed concrete girder, and one with others (steel girder) in the pilot group; while in the control group, there are four bridges with prestressed concrete girders, twenty-one bridges with concrete flat slab, no bridges with continuous prestressed concrete girder, and twenty-three other types of bridges (e.g., continuous concrete haunched slab, continuous steel girder, prestressed concrete girder, prestressed concrete girder, steel girder, etc.).

In the pilot group, there are six bridges with bridge approach slabs and ten bridges without approach slabs. In the control group, four bridges have approach slabs and forty-one bridges do not have approach slabs. All bridges are over water in the pilot group, while there are forty-three bridges over water, two over highway, one over land, and two over the railroad in the control group. All bridges in both the pilot group and control group have utilities on the bridge or overhead utilities, erosion control requirements, and environmental impact/restrictions due to fish and birds. Thirteen out of sixteen pilot projects require Army Corps of Engineers permits, while all but one control project require permits. There are hazardous materials noted for all sixteen pilot projects, while forty-five out of forty-six control projects indicated the presence of hazardous materials. The pilot group includes five rehabilitation projects and eleven replacement projects while the control group includes nine rehabilitation projects and thirty-seven replacement projects. In the pilot group, there are five bridges with concrete overlay and eleven bridges with asphalt overlay; while in the control group, the corresponding numbers are six and forty, respectively. All pilot and control

projects involve road closures, with a detour required in all sixteen pilot projects and forty-one out of forty-six control projects. The descriptive statistics of the categorical data indicate that most of the categorical data are consistent between the pilot and control groups.

A detailed evaluation of the performance measures for Analysis #1 is shown in Appendix E and summarized at the end of this section.

Analysis #2: Excluding Long Bridges in the Control Group

Statistical analysis of the full data (Table 5) indicates that bridge length is significantly larger in the control group. The long bridges in the control group may skew the performance measures. Thus, in this analysis, the research team excluded bridges with lengths greater than 122.10 ft (the maximum bridge length in the pilot group). Out of the 50 control bridges, 7 have a length greater than 122.10 ft and 3 have missing length information. As a result, 16 pilot projects and 40 control projects were used in the analysis.

Descriptive statistics of the contributing data items (continuous variables) are shown in Table 6. This time, bridge length and deck area have similar values between the pilot group and control groups, which is also the case for the rest of the data items. T-test results in Table 6 also prove that there is no significant difference between the pilot and control groups in the continuous contributing data items (bridge length included) (The difference is not statistically significant as all p-values are larger than 0.05). Therefore, the modified control group in Analysis #2 is more reliable than the original group in terms of statistical comparison.

Table 6 Statistical Analysis on Contributing Data Items – Long Bridges Excluded

		Bridge Length (ft)	Deck Width (ft)	Deck Area (sqft)	Span Length (ft)	Design speed (mph)	Approach pavement length (ft)	ADT	Detour length (mile)
Pilot Group (16)	Mean	57.53	35.09	2086.25	44.71	45.00	144.10	1750.56	6.60
	Standard Error	7.54	2.99	332.25	3.11	2.37	26.78	826.33	1.45
	Minimum	32.50	26.50	861.00	30.00	30.00	0.00	22.00	1.00
	Maximum	122.10	67.00	4395.00	66.50	55.00	405.80	11400.00	16.00
	Count	16	16	16	16	16	16	16	10
Control Group (40)	Mean	54.45	34.68	1969.81	42.26	42.86	185.91	1282.37	10.86
	Standard Error	4.15	1.98	233.68	2.64	1.87	20.35	417.87	4.54
	Minimum	23.00	22.70	767.00	10.70	25.00	56.00	10.00	1.00
	Maximum	122.90	77.50	8277.00	110.00	60.00	560.00	14100.00	124.00
	Count	40	40	40	40	35	35	38	37
t-test	t Stat	0.36	0.12	0.29	0.60	0.71	-1.24	0.51	-0.89
	P(T<=t) one-tail	0.36	0.45	0.39	0.28	0.24	0.11	0.31	0.19
	t Critical one-tail	1.71	1.70	1.70	1.69	1.69	1.69	1.71	1.68

Descriptive statistics of the continuous performance measures are shown in Table 7. The table shows similar results as in *Analysis #1*. All budget measures (cost per sq ft, total design delivery cost, total design delivery cost per sq ft, total construction delivery cost, total construction delivery cost per sq ft) and most schedule measures (number of days from scheduled PSE at initiation to actual PSE delivery, "Design Delivery Time") have better performance (lower mean value) in the pilot group when compared to the modified control group. Only Schedule #3 (number of days from substantially complete to records and quantities submitted) and Quality #2 (percentage of construction contract modification) do not improve in the pilot group (higher mean value). T-test results (Table 7) validate the improvements noted in the pilot projects as statistically significant (low p-values). The differences noted in Schedule #3 and Quality #2 are not statistically significant.

Table 7 Statistical Analysis on Performance Metrics - Long Bridges Excluded

		Cost Per SqFt	Total Design Delivery Cost	Total Design Delivery Cost Per SqFt	Total Construction Delivery Cost	Total Construction Delivery Cost Per SqFt	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Number of Days From Substantially Complete to Records and Quantities Submitted	Percentage of Construction Contract Modification
Pilot Group (16)	Mean	208.18	51532.55	35.18	41818.43	26.60	19.00	476.00	138.07	0.03
	Standard Error	21.88	1944.50	4.50	4133.85	3.32	17.10	58.16	25.08	0.02
	Minimum	36.82	39787.10	9.30	20422.28	8.00	0.00	200.00	11.00	-0.03
	Maximum	315.19	68062.09	54.97	67229.55	53.00	274.00	866.00	286.00	0.24
	Count	16	16	16	15	15	16	16	15	15
Control Group (40)	Mean	282.77	77184.76	47.02	78592.70	43.00	156.33	773.55	104.52	0.01
	Standard Error	10.74	5716.28	3.09	7732.29	2.69	52.09	49.83	11.71	0.00
	Minimum	117.86	34792.45	8.46	29130.89	22.00	-274.00	148.00	25.00	0.00
	Maximum	447.90	206727.44	90.51	229556.40	73.00	1492.00	1624.00	252.00	0.10
	Count	39	38	38	29	29	40	40	29	29
t-test	t Stat	-3.06	-4.25	-2.17	-4.19	-3.84	-2.50	-3.89	1.21	0.90
	P(T<=t) one-tail	0.00	0.00	0.02	0.00	0.00	0.01	0.00	0.12	0.19
	t Critical one-tail	1.71	1.68	1.70	1.68	1.69	1.68	1.69	1.72	1.75

Descriptive statistics of the two binary performance metrics Quality #1 (environmental document reviews by WisDOT) & Quality #3 (communication of construction contract modification) were evaluated. For Quality #1, eleven out of sixteen pilot projects have only one review compared to eleven out of thirty-nine in the modified control group. For Quality #3, three out of ten pilot projects have successful communication compared to six out of thirteen in the modified control

group. Quality #1 performs better in the pilot group while Quality #3 does not perform better. The research team used the Chi-squared test to compare the binary performance metrics. A Chi-squared test is a statistical test that is used to compare two groups with categorical variables. The p-value for the comparison in Quality #1 is 0.006 (<0.05), indicating that the improved performance in the pilot group is statistically significant. The p-value for the comparison in Quality #3 is 0.42(>0.05), so the improvement noted for the modified control group with respect to this measure is not statistically significant.

After the statistical evaluation of pilot project using available data, the performance measures/criteria developed by WisDOT were also used to assess the pilot program. Note that the WisDOT criteria used in this study were updated on 01/13/2020 [1].

Future updates may affect the results reported here.

Table 8, Table 9, and Table 10 show the results based on WisDOT's performance criteria for budget, schedule, and quality, respectively. The green color in any cells indicates that the pilot program met the stated criteria and is therefore considered a success (in meeting the criteria).

Based on WisDOT's criteria for Budget #1, project cost will be "*considered a success if 75% or more of the Low-Risk bridges cost less than the average of the Control Group for the appropriate improvement type"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and thirty-six modified control projects (3 rehabilitation and 33 replacement) were used to evaluate Budget #1. This measure can be considered a success since 75% (12/16) =75% met the stated criterion.

Based on WisDOT's criteria for Budget #2, project delivery will be deemed "a *success if the majority of the Low-Risk projects have delivery costs lower than the average delivery cost of the Control Group"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and twenty-six control projects (1 rehabilitation and 25 replacement) were used to evaluate Budget #2. This measure can be considered a success since 100% (16/16) >50% met the stated criteria. Budget #2 was also evaluated using the normalized total delivery cost recommended by the research team. This measure can also be considered a success since 81.25% (13/16) > 50% met the stated criteria.

Table 8 Pilot Program Evaluation using WisDOT's Performance Criteria (Budget) – Long Bridges Excluded

		Budget					
		#1 Project Cost		#2 Project Delivery			
Improvement Type	Design ID	Cost Per Sq Ft	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost Per SqFt	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	37	224 (3 cases)	40855	360668 (1 case)	9	44 (1 case)
	2718-20-00	49		71518		18	
	8844-00-01	111		98879		25	
	7894-03-03	137		87345		22	
	2790-03-00	145		110906		33	
Replacement	7027-00-00	206	280 (33 cases)	107046	142515 (25 cases)	74	87 (25 cases)
	8827-00-00	209		83900		51	
	6500-03-00	212		106267		96	
	3636-00-02	256		89973		86	
	9443-01-00	257		123649		67	
	5329-00-00	265		76581		67	
	4665-01-00	271		127753		88	
	8317-00-00	281		76920		76	
	8333-00-00	289		69546		81	
	8328-00-00	290		71257		66	
	3818-00-00	315		109404		104	
Measurement		Success 75% (12/16) =75%		Success 100% (16/16) > 50%		Success 81.25% (13/16) >50%	

Based on WisDOT's criteria for Schedule #1, design schedule will be "*considered a success if i) The actual PSE delivery date is on or before the original PSE scheduled date for at least 75% of Low-Risk projects, ii) The average number of days of delay for Low-Risk program does not exceed the average number of days of the Control Group"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and thirty-six control projects were used to evaluate Schedule #1. This measure can be considered a success

since both of the following conditions were satisfied: *i)* 87.5% (14/16) > 75%, and *ii)* Average value for the pilot =19 < 208.54 (Average value for the 36 control projects).

Table 9 Pilot Program Evaluation using WisDOT's Performance Criteria (Schedule) - Long Bridges Excluded

		Schedule				
		#1 Design Schedule	#2 Delivery Schedule		#3 Construction Finals	
Improvement Type	Design ID	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Average Value of the Control Group for the Same Improvement Type	Number of Days From Substantially Complete to Records and Quantities Submitted	=<180 days
Rehabilitation	2718-19-00	0	866	988 (3 cases)		
	2718-20-00	0	629		11	Yes
	8844-00-01	274	484		78	Yes
	7894-03-03	0	497		79	Yes
	2790-03-00	0	741		127	Yes
Replacement	7027-00-00	0	523	743 (33 cases)	56	Yes
	8827-00-00	30	263		183	No
	6500-03-00	0	355		92	Yes
	3636-00-02	0	536		49	Yes
	9443-01-00	0	208		63	Yes
	5329-00-00	0	796		118	Yes
	4665-01-00	0	355		92	Yes
	8317-00-00	0	200		286	No
	8333-00-00	0	200		286	No
	8328-00-00	0	200		286	No
	3818-00-00	0	763		265	No
Measurement		Success a. 87.5% (14/16) > 75% b. Average value for the pilot =19 < 208.54 (Average value for the 36 control cases)	Success 87.5% (14/16) >75%		Failure 66.67% (10/15) <100%	

Based on WisDOT's criteria for Schedule #2, delivery schedule will be "*considered a success if 75% of the project design times in the Low-Risk pilot are less than the average design delivery time of the Control Group"*. The average values of the control group for the same improvement

type were calculated. Available data from sixteen pilot projects and thirty-six control projects (3 rehabilitation and 33 replacement) were used to evaluate Schedule #2. This measure can be considered a success since 87.5% (14/16) >75% met the stated criteria.

Based on WisDOT's criteria for Schedule #3, construction finals will be "*considered a success if 100% of projects complete the finals process within 6 months"*. Available data from fifteen pilot projects were used to evaluate Schedule #3. This measure **cannot** be considered a success since 66.67% (10/15) <100% did not meet the stated criteria.

Based on WisDOT's criteria, Quality #1: environmental document reviews will be "*considered a success if 75% of projects in the Low-Risk pilot achieve the one review goal"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects were used to evaluate Quality #1. This measure **cannot** be considered a success since 68.75% (11/16) <75% did not meet the stated criteria.

Based on WisDOT's criteria, Quality #2: construction contract modifications will be "*considered a success if i) The majority of Low-Risk projects have a change order percentage less than the average percentage of the Control Group, ii) The Change Order percentage for Low-Risk program is less than 5%"*. The average values of the control group for the same improvement type were calculated. Available data from fifteen pilot projects and twenty-six control projects (1 rehabilitation and 25 replacement) were used to evaluate Quality #2. This measure can be considered a success since both of the following conditions were satisfied: *i)* 73.33% (11/15) >50%, and *ii)* Average value for the pilot =2.16% <5%.

Based on WisDOT's criteria, Quality #3: communication of construction contract modifications will be "*a success if the number of modification justifications received by the LPA, matches the total number of modifications on the project"*. Available data from ten pilot projects were used to evaluate Quality #3. This measure **cannot** be considered a success since 30% (3/10) <100% did not meet the stated criteria.

Table 10 Pilot Program Evaluation using WisDOT's Performance Criteria (Quality) - Long Bridges Excluded

		Quality				
		#1 Environmental Document Reviews		**#2 Construction Contract Modification**		**#3 Construction Contract Modifications – Communication**
Improvement Type	Design ID	# Environ Document Reviews by WisDOT	=1	Percentage	Average Value of the Control Group for the Same Improvement Type	If the number of modification justifications received by the LPA matches the total number modifications on the project
Rehabilitation	2718-19-00	1	Yes		6.25% (1 case)	
	2718-20-00	1	Yes	-2.54%		No
	8844-00-01	1	Yes	1.91%		No
	7894-03-03	2	No	0.00%		Yes
	2790-03-00	2	No	24.11%		No
Replacement	7027-00-00	2	No	0.00%	1.07% (25 cases)	Yes
	8827-00-00	1	Yes	0.15%		
	6500-03-00	1	Yes	0.60%		No
	3636-00-02	2	No	12.83%		No
	9443-01-00	1	Yes	0.63%		No
	5329-00-00	1	Yes	0.00%		Yes
	4665-01-00	2	No	0.14%		No
	8317-00-00	1	Yes	0.59%		
	8333-00-00	1	Yes	1.72%		
	8328-00-00	1	Yes	0.10%		
	3818-00-00	1	Yes	2.06%		
Measurement		Probable Success 68.75% (11/16) < 75%		Success a. 73.33% (11/15) >50% b. Average value for the pilot =2.16% <5%		Failure 30% (3/10) <100%

Analysis #3: Excluding Long Bridges & Super Accelerated Pilot Projects

From the survey and phone interviews as well as project meetings, the research team found out that some pilot projects were bundled together and went through the process that was termed "super accelerated". As a result, the super accelerated pilot projects may affect the overall performance of the pilot group. In *Analysis #3,* the research team treated super accelerated pilot projects as outliers and removed them from the analysis. In this study, four pilot projects in Barron County were identified as super accelerated pilot projects. After the removal of the four super accelerated projects, there were 12 pilot projects and 40 control projects remaining in the analysis. Details on Analysis #3 and its results are shown in Appendix E and summarized at the end of this section.

Analysis #4: Evaluating Budget #2 using Control Projects that did not Utilize Management Consultant

Since some control projects utilized a management consultant leading to increased design oversight cost, Analysis #4 was conducted to evaluate Budget #2, Schedule #1, Schedule #2, Quality #1, and Quality #2 by comparing pilot projects to the control projects with no Management Consultant utilized. In the control group, long bridges (>122.10 ft) and projects utilizing Management Consultant were removed from the analysis. Thus 16 pilot projects and 24 control projects were used. Details on Analysis #4 and its results are shown in Appendix E and summarized at the end of this section.

Summary of the Findings

This section provides a summary of the four types of data analysis used in this study. Analysis #1 used all the available data from pilot and control projects. It was found that, on the whole, bridges in the control group were longer than those in the pilot group. Longer bridges mean higher construction cost and longer project schedule. Hence, in Analysis #2, long bridges were removed from the control group and the same analysis was repeated. Analysis #3 further removed super accelerated pilot projects due to the concern that they may affect the overall evaluation of the pilot program. Lastly, the control projects utilizing a management consultant were excluded in Analysis #4 to avoid any effects due to the additional design oversight cost.

Table 11 shows a summary of the four analyses in which the cells are color coded: green is for a statistically significant improvement or a success, yellow is for a probable improvement (which is not statistically significant) or a probable success, and red means no improvement or a failure. Overall, both the statistical comparisons between the pilot and control groups and the comparison based on WisDOT's performance metrics show consistent outcomes in budget and schedule. For Budget #1 and #2 and Schedule #1 and #2, the pilot program significantly improves the project performance, which agrees with the conclusion drawn based on the WisDOT's measures/criteria. For Schedule #3, both methods suggest that the pilot program does not seem to improve the project performance.

For the quality measures, different outcomes are observed. For Quality #1, the pilot program improves the project performance in a statistically significant manner (based on statistical analyses) but would not be considered a success based on WisDOT's performance measures. Although there are more bridges with only one environmental document review in the pilot group than in the control group, the number of bridges still misses WisDOT's target of 75% to be considered as a success. For Quality #2, the pilot program does not improve the performance based on the statistical analysis, while it meets WisDOT's criterion for success. After looking into the data, we have noted that a few pilot projects have higher percentage of construction contract modifications (e.g., 24.11%). These projects affect the average performance of the pilot group. For Quality #3, an improvement in the pilot program is not observed. At the same time, this measure is not a success according to the WisDOT performance measure.

The discrepancies between the performance outcomes are caused by fundamental differences in the two methods. The statistical comparison undertaken by the research team compares the average value of the bridge parameters in the pilot group with the corresponding average value in the control group. It treats bridges as a group. The WisDOT method, however, compares individual bridge values in the pilot group against the average value of the control group, and then applies a subjective threshold value to determine how many pilot sites exceeded or did not exceed the control group average. If the data points are not too dispersed (i.e., few outliers), the two methods may yield consistent results because the average value is susceptible to outliers. Since WisDOT's method depends on the choice of pass/fail limits, one can always find a threshold value that results in the same conclusion as the statistical comparison between group values. Therefore, the two methods can be complementary, and thus can provide a robust assessment of the pilot program.

In short, all four sets of data analyses show similar evaluation results for the pilot program: 1) better performance in budget, 2) better performance in schedule except for Schedule #3: construction finals, and 3) mixed performance in quality, depending on the evaluation method.

Table 11 Summary of Quantitative Evaluation of the Pilot Program*

			Budget		Schedule			Quality		
			#1	#2	#1	#2	#3	#1	#2	#3
Analysis #	**Data**	**Evaluation Method**	**Project Cost**	**Project Delivery**	**Design Schedule**	**Delivery Schedule**	**Construction Finals**	**Environmental Document Reviews**	**Construction Contract Modification**	**Construction Contract Modification - Communication**
1	Full Data	Data-driven Statistical Approach								
		Performance Criteria by WisDOT								
2	Long Bridges Excluded	Data-driven Statistical Approach								
		Performance Criteria by WisDOT								
3	Long Bridges Excluded Super Accelerated Bridges Excluded	Data-driven Statistical Approach								
		Performance Criteria by WisDOT								
4	Long Bridges Excluded No Management Consultant	Data-driven Statistical Approach								
		Performance Criteria by WisDOT								

***Notes**

	Data-driven Statistical Approach	**Performance Criteria by WisDOT**
	Improved, statistically significant	Success
	Improved, not statistically significant	Probable Success
	No improvement	Failure

CONCLUSIONS & RECOMMENDATIONS

In this study, the comprehensive performance of WisDOT's Low-Risk bridge pilot program was evaluated using both qualitative and quantitative methods. The qualitative methods were the online survey and follow-up phone interviews, and the quantitative methods involved a statistical comparison between group average values for the pilot and control projects as well as assessments of a set of performance metrics developed by WisDOT.

In this evaluation, both the survey and data analysis results produce remarkably similar outcomes. Survey results show that most respondents believed that the pilot program can maintain or lower the project cost, which is consistent with the results from data analysis (i.e., better performance in budget for pilot projects). Survey results also show that a slight majority of respondents believed that the pilot program could maintain or lower project time, and the data analysis indicates better performance in project schedule except for Schedule #3 (construction finals). Survey results do not indicate a consensus about the pilot program's impact on project quality, and the data analysis shows mixed results from the two quantitative methods.

Based on the survey results, the research team recommends different training programs for WisDOT and the local government staff to ensure a successful pilot program. The training should be focused on three aspects. First, the goals of the program and ways to successfully implement them should be clarified. Each stakeholder's tasks and responsibilities should be clearly communicated and understood by all parties. Second, the reduced oversight requirements of the Low-Risk pilot program (when compared with the traditional projects) should be understood by all, and the expectations from all sides should be clarified. Third, the local government staff who want to participate in the program need to be trained to meet a minimum set of technical qualifications.

Based on the results from data analysis, the research team recommends modifications to some of WisDOT's performance measures (i.e., the quality performance metrics). For example, more discussion should be had on determining the thresholds for successful WisDOT performance measures. Moreover, more efforts should be put into improving the project process to 1) reduce the time between the substantial completion date and the date that all records and agreed quantities are submitted to WisDOT for review, 2) limit the number of environmental document reviews to one, 3) reduce the percentage of construction contract modification, and 4) strengthen the communication between LPA and WisDOT on the construction contract modification.

REFERENCES

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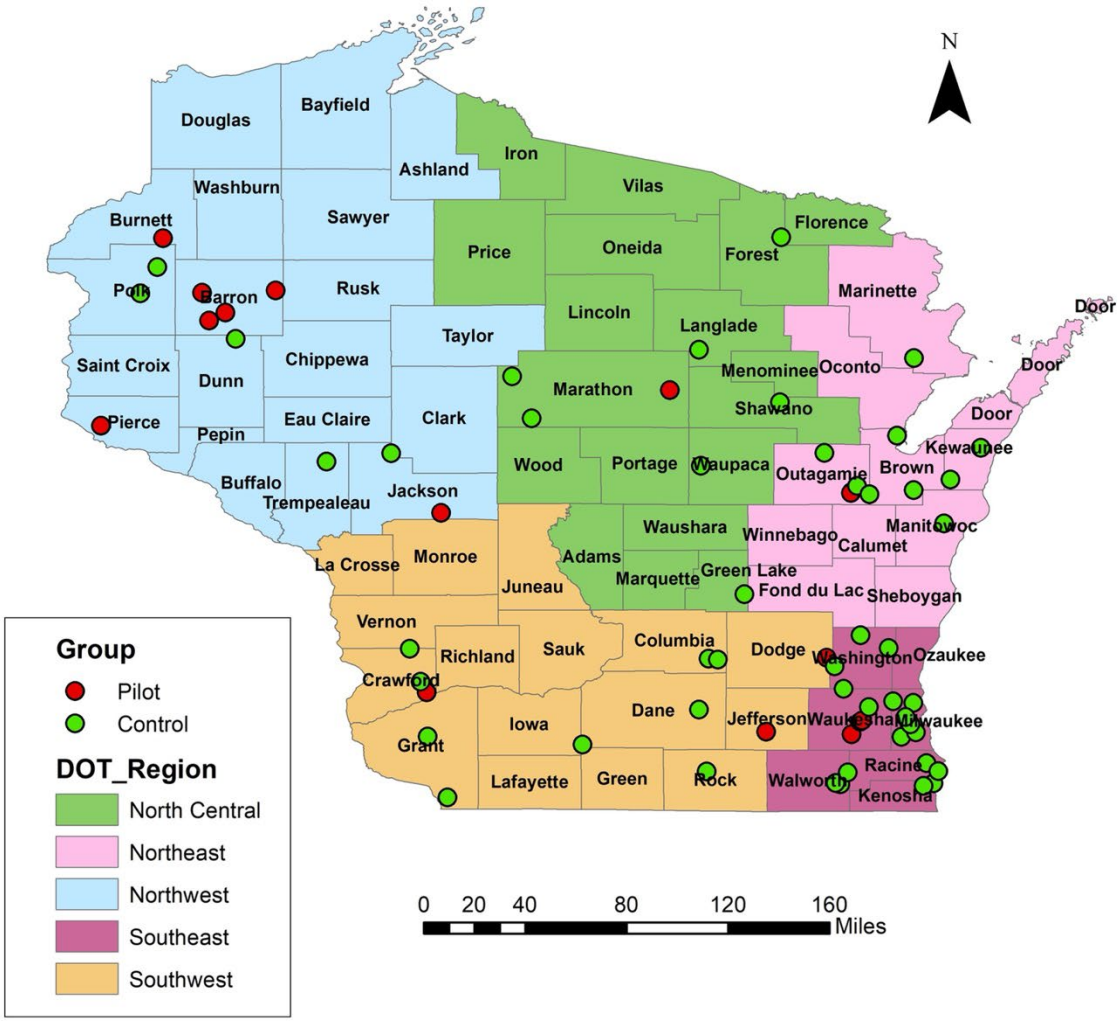
[2] "Federal-aid Project Development Guide For Local Public Agencies," 2020. [Online]. Available: https://iowadot.gov/local_systems/publications/im/federal-aid-guide.pdf.

[3] "Innovative Project Delivery," [Online]. Available: https://idot.illinois.gov/transportation-system/transportation-management/planning/innovative-project-delivery.html. [Accessed 2021].

APPENDICES

Appendix A: Map of Pilot and Control Projects



Appendix B: Sample Database

Bridge Name			Clam River Bridge
Identifying Information	**Region**		NW
	County		Burnett
	Design ID		8844-00-01
	Construction ID		8844-00-71
Bridge Contributing Information	**Bridge Characteristic Information**	Bridge Length (ft)	121.8
		Deck Width (ft)	32
		Deck Area (sqft)	3897
		Number of Spans	2
		Span Length (or Max Span Length if more than one span) (ft)	59.8
		Type of Bridge Superstructure	Continuous prestressed concrete deck girder
		Bridge Approach Slab Used?	No
	Site, Utilities, and Environmental Information	Bridge over water, road, or railroad?	Water
		Utilities on bridge, or overhead utilities	Yes
		Erosion control requirements	Yes
		Impact and restrictions due to fish, birds... (PSE)	Yes
		Army Corps of Engineers permit required?	Yes
		Hazardous materials	Yes
	Highway Design and Construction Information	Type of project (new construction, replacement, repair, and rehabilitation)	Rehabilitation
		Type of pavement (asphalt, concrete, gravel…)	Asphalt
		Design speed for roadway (mph)	55
		Approach pavement length to be reconstructed (on both sides of bridge) (ft)	102.8
	Traffic Control and Detours	Road closure	Yes
		ADT	239
		Detour	Yes
		Detour length (mile)	12
	Construction Quality Data	Design Quality Index	No
Budget	**Budget #1 - Project Cost**	Low Bid Price/Amount	$ 434,400.11
		Bridge Deck Sq Ft	3897
		Cost Per Sq Ft	$ 111.47
	Budget #2 - Project Delivery	Consultant Design Delivery Cost (invoiced)	$ 37,461.03
		WisDOT Design Oversight Cost	$ 9,667.79
		Local Government Design Delivery Cost (invoiced)	$ -
		Total Design Delivery Cost (Consultant + WisDOT + Local)	$ 47,128.82
		Consultant Construction Oversight Cost (invoiced)	$ 47,539.60
		WisDOT Construction Oversight Cost	$ 4,210.38
		Local Government Construction Oversight Cost (invoiced)	$ -
		Total Construction Delivery Cost (Consultant + WisDOT + Local)	$ 51,749.98
Schedule	**Schedule #1 - Design Schedule**	Scheduled PSE Date at Initiation	2/1/20
		Actual PSE Delivery Date	11/1/20
		Number of Days Delay	274
	Schedule #2 - Delivery Schedule	Design Notice to Proceed Date (used Contract "Date Authorized" [from CARS] as proxy)	10/14/19
		Let Date	2/9/21
		"Design Delivery Time"	484
	Schedule #3 - Construction Finals	Substantial Completion Date	8/25/21
		Date Records and Quantities Submitted to WisDOT for Review	11/11/21
		Difference 180 Days or Less? (green if yes, red if no)	78

Bridge Name			Clam River Bridge
Quality	Quality #1 - Environ Document Reviews	# Environ Document Reviews by WisDOT (green if 1, red otherwise)	1
	Quality #2 - Construction Contract Modifications	Value of State-Funded Construction Contract Mods	$ 8,301.72
		Construction Bid Amount	$ 434,400.11
		Percentage	1.91%
	Quality #3 - Construction Contract Modifications - Communication	# Notifications of Construction Contract Mods Known to LPA	0
		# Construction Contract Modifications	1
		Equal? (green if yes, red if no)	No

Appendix C: Survey Questions

Introduction

The Institute of Physical Infrastructure and Transportation (IPIT) at the University of Wisconsin-Milwaukee (UWM) is conducting a research study for the Wisconsin Department of Transportation (WisDOT) with the goal of evaluating the Local Bridge Improvement Assistance Program (Low Risk Pilot Program). In 2019, a pilot program to streamline the delivery and oversight of Low-Risk local bridge projects was initiated by WisDOT. This survey is an important component of an assessment of this pilot program. WisDOT has identified you as an individual with the knowledge of this program who can provide us important feedback about the program through this survey. The survey will be conducted in two parts. In the first part, we conduct an online survey with 12 questions. Unless you opt out, we may contact you by telephone to seek more detailed information.
The research team greatly appreciates your time and input.

Please provide us with the following contact information (Optional): If you wish to provide your responses anonymously, or if you do not wish to be contacted to discuss the survey, you can leave the following fields blank.

- ○ Name: _____
- ○ Affiliation: _____
- ○ Phone: _____
- ○ Email: _____

Q1: **Please select your role in the local bridge pilot project:**

- ○ WisDOT project manager
- ○ County official
- ○ Design engineer
- ○ Contractor
- ○ Other (please specify) _____

Q2: Have you been involved in the development of the pilot program, or have knowledge of at least one project performed under that program?

- ○ Yes
- ○ No

Q3: How would you characterize your knowledge and understanding of the subject local bridge pilot program? (For example, a WisDOT Project Manager who managed a pilot bridge project would be classified as "High" and a person with only indirect knowledge of a pilot project may choose "Low".)

- ○ High
- ○ Medium
- ○ Low

Q4: In your view, does the pilot program have the potential to maintain or improve the quality of Low-Risk bridge projects?

- ○ Maintain the quality
- ○ Improve the quality
- ○ Neither maintain nor improve
- ○ Not sure

Q5: In your view, does the pilot program have the potential to maintain or improve the timeliness (project schedule) of Low-Risk bridge projects?

- ○ Maintain the project schedule
- ○ Accelerate the project schedule
- ○ Neither maintain nor accelerate
- ○ Not sure

Q6: In your view, does the pilot program have the potential to maintain or reduce the delivery costs of Low-Risk bridge projects?

- ○ Maintain the same cost
- ○ Lower the cost
- ○ Increase the cost
- ○ Not sure

Q7: What do you see as the major strengths of the pilot program? Please specify.

_____

_____

Q8: What do you see as the major weaknesses of the pilot program? Please specify.

_____

_____

Q9. In your view, what are the most important metrics/measures for assessing the success/failure of the subject pilot program?

_____

_____

Q10. Considering the goals of the pilot program (streamlined delivery through increased delegation of tasks to local authorities) and your impression of how the pilot program is performing, should the current pilot program become permanent? Please provide your comments in the space provided.

○ Yes _____

○ No _____

Q11. In your opinion, should any other project delivery tasks (or other project types) be delegated to local authorities for the sake of improvement in project delivery? Please provide any suggestions in the space provided.

○ Yes _____

○ No _____

Q12. Please provide any other comments on the subject pilot program.

_____

_____

Appendix D: Original Survey Results in Tables

		WisDOT Project Manager	County Official	Design Engineer	Other
Q4	Maintain the quality	2	0	1	0
	Improve the quality	0	3	0	2
	Neither maintain nor improve	5	1	0	2
	Not sure	2	1	0	1
Q5	Maintain the project schedule	2	0	0	1
	Accelerate the project schedule	1	4	1	2
	Neither maintain nor accelerate	4	0	0	1
	Not sure	2	1	0	1
Q6	Maintain the same cost	3	0	0	1
	Lower the cost	2	4	0	2
	Increase the cost	1	0	1	1
	Not sure	3	1	0	1
Q10	Yes	2	5	0	4
	No	7	0	1	1
Q11	Yes	3	4	1	1
	No	5	1	0	4

Appendix E: Details on the Data Analysis & Results

Analysis #1: Full Data

Descriptive statistics of the continuous performance measures are shown in the following table. The table shows that all budget measures (cost per sq ft, total design delivery cost, total design delivery cost per sq ft, total construction delivery cost, total construction delivery cost per sq ft) and most schedule measures (number of days from scheduled PSE at initiation to actual PSE delivery, "Design Delivery Time") have better performance (lower mean value) in the pilot group when compared to the control group. Only Schedule #3 (number of days from substantially complete to records and quantities submitted) and Quality #2 (percentage of construction contract modification) did not improve in the pilot group (i.e., had a higher mean value). To assess if the difference is statistically significant, the research team used a t-test to compare the continuous performance metrics. T-test results are shown in the table below. From the table, we can see that the differences (where pilot projects have improved) are statistically significant (lower p-value). The differences in Schedule #3 and Quality #2 are not statistically significant. Therefore, we cannot conclusively state whether the noted differences in mean values are statistically significant.

Descriptive statistics of two categorical performance metrics: Quality #1 (environmental document reviews by WisDOT) and Quality #3 (communication of construction contract modification) were determined. The two metrics are binary variables (i.e., whether there is only one environmental review, and whether the communication is a success). For Quality #1, eleven out of sixteen pilot projects have only one review compared to twelve out of fifty in the control group. For Quality #3, three out of ten pilot projects have successful communication compared to eight out of sixteen bridges in the control group. It appears that Quality #1 performs better in the pilot group while Quality #3 does not. To measure if the difference is statistically significant, the research team used the Chi-squared test to compare the binary performance metrics. The p-value for the comparison in Quality #1 is 0.001 (<0.05), indicating that the improved performance in the pilot group is statistically significant. The p-value for the comparison in Quality #3 is 0.32(>0.05), so the decrease noted in the pilot group with respect to this measure is not statistically significant. This is likely due to the relatively low response rate from the LPA contacts to our inquiry regarding Quality #3 data. The research team had contacted the LPAs to obtain data for this quality measure.

Table Statistical Analysis on Performance Metrics - Full Data

		Cost Per SqFt	Total Design Delivery Cost	Total Design Delivery Cost Per SqFt	Total Construction Delivery Cost	Total Construction Delivery Cost Per SqFt	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Number of Days From Substantially Complete to Records and Quantities Submitted	Percentage of Construction Contract Modification
Pilot Group (16)	Mean	208.18	51532.55	35.18	41818.43	26.60	19.00	476.00	138.07	0.03
	Standard Error	21.88	1944.50	4.50	4133.85	3.32	17.10	58.16	25.08	0.02
	Minimum	36.82	39787.10	9.30	20422.28	8.00	0.00	200.00	11.00	-0.03
	Maximum	315.19	68062.09	54.97	67229.55	53.00	274.00	866.00	286.00	0.24
	Count	16	16	16	15	15	16	16	15	15
Control Group (50)	Mean	258.66	82564.58	43.23	87365.96	40.94	212.22	755.32	110.63	0.01
	Standard Error	12.67	6220.28	3.18	9076.81	2.72	82.01	43.36	12.52	0.00
	Minimum	65.06	34792.45	3.35	29130.89	10.00	-274.00	148.00	25.00	-0.03
	Maximum	447.90	212233.43	90.51	241154.52	73.00	3653.00	1624.00	312.00	0.10
	Count	48	45	43	32	32	50	50	32	32
t-test	t Stat	-2.00	-4.76	-1.46	-4.57	-3.34	-2.31	-3.85	0.98	0.85
	P(T<=t) one-tail	0.03	0.00	0.08	0.00	0.00	0.01	0.00	0.17	0.20
	t Critical one-tail	1.71	1.67	1.70	1.68	1.69	1.67	1.69	1.72	1.75

As part of the program evaluation, performance criteria developed by WisDOT were also calculated. The following three tables show the results based on WisDOT's performance criteria for budget, schedule, and quality, respectively. The green color in any cell indicates that the pilot program met the stated criteria and is therefore considered a success.

Based on WisDOT's criteria for Budget #1, project cost will be "*considered a success if 75% or more of the Low-Risk bridges cost less than the average of the Control Group for the appropriate improvement type")*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and forty-five control projects (9 rehabilitation and 36 replacement) were used in the analysis. This measure can be considered a success since 75% (12/16) =75% met the stated criteria.

Based on WisDOT's criteria for Budget #2, project delivery will be deemed "a *success if the majority of the Low-Risk projects have delivery costs lower than the average delivery cost of the Control Group"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and twenty-nine control projects (3 rehabilitation and 26 replacement) were used in the analysis. Budget #2 can be considered a

success since 100% (16/16) >50% met the stated criteria. Project delivery was also evaluated using the normalized total delivery cost recommended by the research team. This measure can be considered a success since 75% (12/16) > 50% met the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Budget) - Full Data

		Budget					
		#1 Project Cost		#2 Project Delivery			
Improvement Type	Design ID	Cost Per Sq Ft	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost Per SqFt	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	37	147 (9 cases)	40855	295216 (3 cases)	9	33 (3 cases)
	2718-20-00	49		71518		18	
	8844-00-01	111		98879		25	
	7894-03-03	137		87345		22	
	2790-03-00	145		110906		33	
Replacement	7027-00-00	206	277 (36 cases)	107046	149112 (26 cases)	74	85 (26 cases)
	8827-00-00	209		83900		51	
	6500-03-00	212		106267		96	
	3636-00-02	256		89973		86	
	9443-01-00	257		123649		67	
	5329-00-00	265		76581		67	
	4665-01-00	271		127753		88	
	8317-00-00	281		76920		76	
	8333-00-00	289		69546		81	
	8328-00-00	290		71257		66	
	3818-00-00	315		109404		104	
Measurement		Success 75% (12/16) =75%		Success 100% (16/16) > 50%		Success 75% (12/16) > 50%	

Based on WisDOT's criteria for Schedule #1, design schedule will be "*considered a success if i) The actual PSE delivery date is on or before the original PSE scheduled date for at least 75% of Low-Risk projects, ii) The average number of days of delay for Low-Risk program does not exceed*

the average number of days of the Control Group". The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and forty-six control projects were used in the analysis. This measure can be considered a success since both of the following conditions were met: *i)* 87.5% (14/16) > 75%, and *ii)* Average value for the pilot =19 < 212.22 (Average value for the 46 control projects).

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Schedule) - Full Data

		Schedule				
		#1 Design Schedule	**#2 Delivery Schedule**		**#3 Construction Finals**	
Improvement Type	Design ID	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Average Value of the Control Group for the Same Improvement Type	Number of Days From Substantially Complete to Records and Quantities Submitted	=<180 days
Rehabilitation	2718-19-00	0	866	703 (9 cases)		
	2718-20-00	0	629		11	Yes
	8844-00-01	274	484		78	Yes
	7894-03-03	0	497		79	Yes
	2790-03-00	0	741		127	Yes
Replacement	7027-00-00	0	523	756 (37 cases)	56	Yes
	8827-00-00	30	263		183	No
	6500-03-00	0	355		92	Yes
	3636-00-02	0	536		49	Yes
	9443-01-00	0	208		63	Yes
	5329-00-00	0	796		118	Yes
	4665-01-00	0	355		92	Yes
	8317-00-00	0	200		286	No
	8333-00-00	0	200		286	No
	8328-00-00	0	200		286	No
	3818-00-00	0	763		265	No
Measurement		Success a. 87.5% (14/16) > 75% b. Average value for the pilot =19 < 212.22 (Average value for the 46 control)	Success 75% (12/16) =75%		Failure 66.67% (10/15) <100%	

Based on WisDOT's criteria for Schedule #2, delivery schedule will be "*considered a success if 75% of the project design times in the Low-Risk pilot are less than the average design delivery time of the Control Group"*. The average values of the control group for the same improvement type were calculated. Available data from sixteen pilot projects and forty-six control projects (9 rehabilitation and 37 replacement) were used in the analysis. This measure can be considered a success since 75% (12/16) =75% met the stated criteria.

Based on WisDOT's criteria for Schedule #3, construction finals will be "*considered a success if 100% of projects complete the finals process within 6 months"*. Available data from fifteen pilot projects were used in the analysis. This measure **cannot** be considered a success since 66.67% (10/15) <100% did not the stated criteria.

Based on WisDOT's criteria, Quality #1: environmental document reviews will be "*considered a success if 75% of projects in the Low-Risk pilot achieve the one review goal"*. The average values of the control group for the same improvement type were calculated. Data from 16 pilot projects were used in the analysis. It **cannot** be considered a success here because 68.75% (11/16)<75%.

Based on WisDOT's criteria, Quality #2: construction contract modifications will be "*considered a success if i) The majority of Low-Risk projects have a change order percentage less than the average percentage of the Control Group, ii) The Change Order percentage for Low-Risk program is less than 5%"*. The average values of the control group for the same improvement type were calculated. Available data from fifteen pilot projects and twenty-nine control projects (3 rehabilitation and 26 replacement) were used in the analysis. It can be considered a success here because both of the following conditions were met: *i)* 73.33% (11/15) >50%, and *ii)* Average value for the pilot =2.82% <5%.

Based on WisDOT's criteria, Quality #3: communication of construction contract modifications will be "*a success if the number of modification justifications received by the LPA, matches the total number of modifications on the project"*. Data from 10 pilot projects were used in the analysis. It **cannot** be considered a success here because 30% (3/10) <100%.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Quality) - Full Data

		Quality				
		#1 Environmental Document Reviews		**#2 Construction Contract Modification**		**#3 Construction Contract Modifications – Communication**
Improvement Type	Design ID	# Environ Document Reviews by WisDOT	=1	Percentage	Average Value of the Control Group for the Same Improvement Type	If the number of modification justifications received by the LPA, matches the total number modifications on the project
Rehabilitation	2718-19-00	1	Yes		4.93% (3 cases)	
	2718-20-00	1	Yes	-2.54%		No
	8844-00-01	1	Yes	1.91%		No
	7894-03-03	2	No	0.00%		Yes
	2790-03-00	2	No	24.11%		No
Replacement	7027-00-00	2	No	0.00%	0.93% (26 cases)	Yes
	8827-00-00	1	Yes	0.15%		
	6500-03-00	1	Yes	0.60%		No
	3636-00-02	2	No	12.83%		No
	9443-01-00	1	Yes	0.63%		No
	5329-00-00	1	Yes	0.00%		Yes
	4665-01-00	2	No	0.14%		No
	8317-00-00	1	Yes	0.59%		
	8333-00-00	1	Yes	1.72%		
	8328-00-00	1	Yes	0.10%		
	3818-00-00	1	Yes	2.06%		
Measurement		Probable Success 68.75% (11/16) <75%		Success a. 73.33% (11/15) >50% b. Average value for the pilot =2.82% <5%		Failure 30% (3/10) <100%

Analysis #3: Excluding Long Bridges & Super Accelerated Pilot Projects

Descriptive statistics and t-test results of the contributing data items (continuous variables) are shown in the table below. The results show there is no statistically significant difference in all continuous contributing data items between the pilot group and the control group (all p-values are larger than 0.05).

Table Statistical Analysis on Contributing Data Items – Long Bridges Excluded, Super Accelerated Bridges Excluded

		Bridge Length (ft)	Deck Width (ft)	Deck Area (sqft)	Span Length (ft)	Design speed (mph)	Approach pavement length (ft)	ADT	Detour length (mile)
Pilot Group (12)	Mean	63.68	37.13	2399.33	47.45	45.42	133.47	2268.83	7.33
	Standard Error	9.43	3.77	403.19	3.77	2.98	33.49	1068.34	2.43
	Minimum	34.50	26.50	1052.00	32.00	30.00	0.00	100.00	1.00
	Maximum	122.10	67.00	4395.00	66.50	55.00	405.80	11400.00	16.00
	Count	12	12	12	12	12	12	12	6
Control Group (40)	Mean	54.45	34.68	1969.81	42.26	42.86	185.91	1282.37	10.86
	Standard Error	4.15	1.98	233.68	2.64	1.87	20.35	417.87	4.54
	Minimum	23.00	22.70	767.00	10.70	25.00	56.00	10.00	1.00
	Maximum	122.90	77.50	8277.00	110.00	60.00	560.00	14100.00	124.00
	Count	40	40	40	40	35	35	38	37
t-test	t Stat	0.90	0.57	0.92	1.13	0.73	-1.34	0.86	-0.69
	P(T<=t) one-tail	0.19	0.29	0.18	0.14	0.24	0.10	0.20	0.25
	t Critical one-tail	1.75	1.73	1.73	1.71	1.72	1.72	1.75	1.69

Descriptive statistics and t-test results of the continuous performance measures are shown in the table below. All budget measures and most schedule measures (Schedule #1 & #2) in the pilot group have statistically significant improvement. In the pilot group, Schedule #3 has a better performance with a statistically insignificant difference, while Quality #2 has not improved.

Table Statistical Analysis on Performance Metrics - Long Bridges Excluded, Super Accelerated Bridges Excluded

		Cost Per SqFt	Total Design Delivery Cost	Total Design Delivery Cost Per SqFt	Total Construction Delivery Cost	Total Construction Delivery Cost Per SqFt	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Number of Days From Substantially Complete to Records and Quantities Submitted	Percentage of Construction Contract Modification
Pilot Group (12)	Mean	188.46	51587.55	31.34	48283.98	28.36	22.83	562.75	93.64	0.04
	Standard Error	26.34	2571.35	5.45	4076.82	4.39	22.83	58.23	19.71	0.02
	Minimum	36.82	39787.10	9.30	26497.35	8.00	0.00	208.00	11.00	-0.03
	Maximum	315.19	68062.09	54.65	67229.55	53.00	274.00	866.00	265.00	0.24
	Count	12	12	12	11	11	12	12	11	11
Control Group (40)	Mean	282.77	77184.76	47.02	78592.70	43.00	156.33	773.55	104.52	0.01
	Standard Error	10.74	5716.28	3.09	7732.29	2.69	52.09	49.83	11.71	0.00
	Minimum	117.86	34792.45	8.46	29130.89	22.00	-274.00	148.00	25.00	0.00
	Maximum	447.90	206727.44	90.51	229556.40	73.00	1492.00	1624.00	252.00	0.10
	Count	39	38	38	29	29	40	40	29	29
t-test	t Stat	-3.32	-4.08	-2.50	-3.47	-2.84	-2.35	-2.75	-0.47	1.00
	P(T<=t) one-tail	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.32	0.17
	t Critical one-tail	1.75	1.68	1.73	1.69	1.73	1.68	1.70	1.73	1.80

Descriptive statistics of the two binary performance metrics of Quality #1 & Quality #3 were determined. For Quality #1, seven out of twelve pilot projects have only one review compared to eleven out of thirty-nine in the control group. For Quality #3, three out of ten pilot projects have successful communication compared to six out of thirteen in the control group. The Chi-squared test was used to compare the binary performance metrics. For the pilot group, the improved performance in Quality #1 is statistically significant (p-value =0.059), while the decrease in Quality #3 is not statistically significant (p-value =0.42).

After the statistical evaluation of pilot projects, performance criteria developed by WisDOT were also used to assess the pilot program. The following three tables show the results based on WisDOT's performance criteria for budget, schedule, and quality, respectively.

Available data from twelve pilot projects and thirty-six control projects (3 rehabilitation and 33 replacement) were used to evaluate Budget #1. This measure can be considered a success since 91.67% (11/12) >75% met the stated criteria. Available data from twelve pilot projects and twenty-six control projects (1 rehabilitation and 25 replacement) were used to evaluate Budget #2. This

measure can be considered a success since 100% (12/12) >50% met the stated criteria. Budget #2 was also evaluated using the normalized total delivery cost recommended by the research team. This measure can be considered a success too since 75% (9/12) > 50% met the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Budget) - Long Bridges Excluded, Super Accelerated Bridges Excluded

		Budget					
		#1 Project Cost		#2 Project Delivery			
Improvement Type	Design ID	Cost Per Sq Ft	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost Per SqFt	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	37	224 (3 cases)	40855	360668 (1 case)	9	44 (1 case)
	2718-20-00	49		71518		18	
	8844-00-01	111		98879		25	
	7894-03-03	137		87345		22	
	2790-03-00	145		110906		33	
Replacement	7027-00-00	206	280 (33 cases)	107046	142515 (25 cases)	74	87 (25 cases)
	6500-03-00	212		106267		96	
	3636-00-02	256		89973		86	
	9443-01-00	257		123649		67	
	5329-00-00	265		76581		67	
	4665-01-00	271		127753		88	
	3818-00-00	315		109404		104	
Measurement		Success 91.67% (11/12) >75%		Success 100% (12/12) > 50%		Success 75% (9/12) > 50%	

Available data from twelve pilot projects and control projects were used to evaluate Schedule #1. This measure can be considered a success since both of the following conditions were met: *i)* 91.67% (11/12) > 75%, and *ii)* Average value for the pilot =23 < 208.54 (Average value for the 36 control projects). Available data from twelve pilot projects and thirty-six control projects (3 rehabilitation and 33 replacement) were used to evaluate Schedule #2. This measure can be considered a success since 83.33% (10/12) =75% met the stated criteria. Available data from eleven pilot projects were used to evaluate Schedule #3. This measure **cannot** be considered a success since 90.91% (10/11) <100% did not meet the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Schedule) - Long Bridges Excluded, Super Accelerated Bridges Excluded

		Schedule				
		#1 Design Schedule	#2 Delivery Schedule		#3 Construction Finals	
Improvement Type	Design ID	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Average Value of the Control Group for the Same Improvement Type	Number of Days From Substantially Complete to Records and Quantities Submitted	=<180 days
Rehabilitation	2718-19-00	0	866	988 (3 cases)		
	2718-20-00	0	629		11	Yes
	8844-00-01	274	484		78	Yes
	7894-03-03	0	497		79	Yes
	2790-03-00	0	741		127	Yes
Replacement	7027-00-00	0	523	743 (33 cases)	56	Yes
	6500-03-00	0	355		92	Yes
	3636-00-02	0	536		49	Yes
	9443-01-00	0	208		63	Yes
	5329-00-00	0	796		118	Yes
	4665-01-00	0	355		92	Yes
	3818-00-00	0	763		265	No
Measurement		Success a. 91.67% (11/12) > 75% b. Average value for the pilot =23 < 208.54 (Average value for the 36 control)	Success 83.33% (10/12) >75%		Probable Success 90.91% (10/11) <100%	

Available data from twelve pilot projects were used to evaluate Quality #1. This measure **cannot** be considered a success since 58.33% (7/12) <75% did not meet the stated criteria. Available data from eleven pilot projects and twenty-six control projects (1 rehabilitation and 25 replacement) were used to evaluate Quality #2. This measure can be considered a success since both of the following conditions were met: *i)* 72.73% (8/11) >50%, and *ii)* Average value for the pilot =3.61% <5%. Available data from ten pilot projects were used to evaluate Quality #3. This measure **cannot** be considered a success here because 30% (3/10) <100% did not met the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Quality) - Long Bridges Excluded, Super Accelerated Bridges Excluded

		Quality				
		#1 Environmental Document Reviews		**#2 Construction Contract Modification**		**#3 Construction Contract Modifications – Communication**
Improvement Type	Design ID	# Environ Document Reviews by WisDOT	=1	Percentage	Average Value of the Control Group for the Same Improvement Type	If the number of modification justifications received by the LPA, matches the total number modifications on the project
Rehabilitation	2718-19-00	1	Yes		6.25% (1 case)	
	2718-20-00	1	Yes	-2.54%		No
	8844-00-01	1	Yes	1.91%		No
	7894-03-03	2	No	0.00%		Yes
	2790-03-00	2	No	24.11%		No
Replacement	7027-00-00	2	No	0.00%	1.07% (25 cases)	Yes
	6500-03-00	1	Yes	0.60%		No
	3636-00-02	2	No	12.83%		No
	9443-01-00	1	Yes	0.63%		No
	5329-00-00	1	Yes	0.00%		Yes
	4665-01-00	2	No	0.14%		No
	3818-00-00	1	Yes	2.06%		
Measurement		Probable Success 58.33% (7/12) < 75%		Success a. 72.73% (8/11) >50% b. Average value for the pilot =3.61% <5%		Failure 30% (3/10) <100%

In short, *Analysis* #3 shows that the pilot program has better performance mainly in budget and schedule, even without considering the super accelerated pilot projects.

Analysis #4: Evaluating Budget #2 using Control Projects that did not Utilize Management Consultant

Descriptive statistics and t-test results of the contributing data items (continuous variables) are shown in the table below. The results show that there is no statistically significant difference in all continuous contributing data items between the pilot group and control group (all p-values are larger than 0.05).

Table Statistical Analysis on Contributing Data Items – Long Bridges Excluded, No Management Consultant

		Bridge Length (ft)	Deck Width (ft)	Deck Area (sqft)	Span Length (ft)	Design speed (mph)	Approach pavement length (ft)	ADT	Detour length (mile)
Pilot Group (16)	Mean	57.53	35.09	2086.25	44.71	45.00	144.10	1750.56	6.60
	Standard Error	7.54	2.99	332.25	3.11	2.37	26.78	826.33	1.45
	Minimum	32.50	26.50	861.00	30.00	30.00	0.00	22.00	1.00
	Maximum	122.10	67.00	4395.00	66.50	55.00	405.80	11400.00	16.00
	Count	16	16	16	16	16	16	16	10
Control Group (24)	Mean	51.21	30.80	1617.00	39.98	40.68	140.96	486.59	10.95
	Standard Error	4.27	1.62	195.98	1.77	2.40	17.58	235.46	5.72
	Minimum	23.00	22.70	767.00	22.00	25.00	56.00	10.00	2.00
	Maximum	116.90	57.00	4446.00	51.50	60.00	374.30	5200.00	124.00
	Count	24	24	24	24	22	22	22	21
t-test	t Stat	0.73	1.26	1.22	1.32	1.28	0.10	1.47	-0.74
	P(T<=t) one-tail	0.24	0.11	0.12	0.10	0.10	0.46	0.08	0.23
	t Critical one-tail	1.71	1.71	1.71	1.71	1.69	1.70	1.74	1.72

Descriptive statistics and t-test results of the continuous performance measures (Budget #2, Schedule #1, Schedule #2, Quality #2) are shown in the table below. All budget measures (Budget #2) and schedule measures (Schedule #1 & #2) in the pilot group have statistically significant improvements, while Quality #2 has not improved. Descriptive statistics of the binary performance metric Quality #1 was determined. For Quality #1, eleven out of sixteen pilot projects have only one review compared to eight out of twenty-four in the control group. The Chi-squared test was used to compare the binary performance metric. For the pilot group, the improved performance in Quality #1 is statistically significant (p-value =0.033).

Table Statistical Analysis on Performance Metrics - Long Bridges Excluded, No Management Consultant

		Total Design Delivery Cost	Total Design Delivery Cost Per SqFt	Total Construction Delivery Cost	Total Construction Delivery Cost Per SqFt	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Percentage of Construction Contract Modification
Pilot Group (12)	Mean	51532.55	35.18	41818.43	26.60	19.00	476.00	0.03
	Standard Error	1944.50	4.50	4133.85	3.32	17.10	58.16	0.02
	Minimum	39787.10	9.30	20422.28	8.00	0.00	200.00	-0.03
	Maximum	68062.09	54.97	67229.55	53.00	274.00	866.00	0.24
	Count	16	16	15	15	16	16	15
Control Group (40)	Mean	74930.37	49.53	60507.40	40.08	84.13	673.83	0.00
	Standard Error	7781.36	3.45	7196.23	3.56	34.71	26.37	0.00
	Minimum	38826.22	27.81	29130.89	26.00	-273.00	487.00	0.00
	Maximum	206727.44	90.51	114114.22	73.00	457.00	909.00	0.03
	Count	22	22	13	13	24	24	13
t-test	t Stat	-2.92	-2.53	-2.25	-2.77	-1.68	-3.10	1.34
	P(T<=t) one-tail	0.00	0.01	0.02	0.01	0.05	0.00	0.10
	t Critical one-tail	1.71	1.70	1.73	1.71	1.69	1.72	1.75

After the statistical evaluation of pilot projects, performance criteria developed by WisDOT were also used to assess the pilot program. The following three tables show the results based on WisDOT's performance criteria for budget, schedule, and quality, respectively.

Available data from sixteen pilot projects and thirteen control projects (0 rehabilitation and 13 replacement) were used to evaluate Budget #2. This measure can be considered a success since 90.91% (10/11) >50% met the stated criteria. Budget #2 was also evaluated using the normalized total delivery cost recommended by the research team. This measure can be considered a success too since 63.64% (7/11) > 50% met the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Budget) – Long Bridges Excluded, No Management Consultant

		Budget #2 Project Delivery			
Improvement Type	Design ID	Total Delivery Cost	Average Value of the Control Group for the Same Improvement Type	Total Delivery Cost Per SqFt	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	40855	-	9	-
	2718-20-00	71518		18	
	8844-00-01	98879		25	
	7894-03-03	87345		22	
	2790-03-00	110906		33	
Replacement	7027-00-00	107046	127064 (13 cases)	74	85 (13 cases)
	8827-00-00	83900		51	
	6500-03-00	106267		96	
	3636-00-02	89973		86	
	9443-01-00	123649		67	
	5329-00-00	76581		67	
	4665-01-00	127753		88	
	8317-00-00	76920		76	
	8333-00-00	69546		81	
	8328-00-00	71257		66	
	3818-00-00	109404		104	
Measurement		Success 90.91% (10/11) > 50%		Success 63.64% (7/11) >50%	

Available data from sixteen pilot projects and twenty-four control projects were used to evaluate Schedule #1. This measure can be considered a success since both of the following conditions were met: *i)* 87.5% (14/16) > 75%, and *ii)* Average value for the pilot =19 < 84 (Average value for the 24 control projects). Available data from sixteen pilot projects and twenty-three control projects (2 rehabilitation and 21 replacement) were used to evaluate Schedule #2. This measure can be considered a success since 81.25% (13/16) >75% met the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Schedule) - Long Bridges Excluded, No Management Consultant

		Schedule		
		#1 Design Schedule	#2 Delivery Schedule	
Improvement Type	Design ID	Number of Days From Scheduled PSE at Initiation to Actual PSE Delivery	"Design Delivery Time"	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	0	866	778 (2 cases)
	2718-20-00	0	629	
	8844-00-01	274	484	
	7894-03-03	0	497	
	2790-03-00	0	741	
Replacement	7027-00-00	0	523	660 (21 cases)
	8827-00-00	30	263	
	6500-03-00	0	355	
	3636-00-02	0	536	
	9443-01-00	0	208	
	5329-00-00	0	796	
	4665-01-00	0	355	
	8317-00-00	0	200	
	8333-00-00	0	200	
	8328-00-00	0	200	
	3818-00-00	0	763	
Measurement		Success a. 87.5% (14/16) > 75% b. Average value for the pilot =19 < 84 (Average value for the 24 control cases)	Success 81.25% (13/16) >75%	

Available data from sixteen pilot projects were used to evaluate Quality #1. This measure **cannot** be considered a success since 68.75% (11/16) <75% did not meet the stated criteria. Available data from sixteen pilot projects and thirteen control projects (13 replacement) were used to evaluate Quality #2. This measure **cannot** be considered a success since 45.45% (5/11) <50%, did not meet the stated criteria.

Table Pilot Program Evaluation using WisDOT's Performance Criteria (Quality) - Long Bridges Excluded, No Management Consultant

		Quality			
		#1 Environmental Document Reviews		#2 Construction Contract Modification	
Improvement Type	Design ID	# Environ Document Reviews by WisDOT	=1	Percentage	Average Value of the Control Group for the Same Improvement Type
Rehabilitation	2718-19-00	1	Yes		-
	2718-20-00	1	Yes	-2.54%	
	8844-00-01	1	Yes	1.91%	
	7894-03-03	2	No	0.00%	
	2790-03-00	2	No	24.11%	
Replacement	7027-00-00	2	No	0.00%	0.44% (13 cases)
	8827-00-00	1	Yes	0.15%	
	6500-03-00	1	Yes	0.60%	
	3636-00-02	2	No	12.83%	
	9443-01-00	1	Yes	0.63%	
	5329-00-00	1	Yes	0.00%	
	4665-01-00	2	No	0.14%	
	8317-00-00	1	Yes	0.59%	
	8333-00-00	1	Yes	1.72%	
	8328-00-00	1	Yes	0.10%	
	3818-00-00	1	Yes	2.06%	
Measurement		Probable Success 68.75% (11/16) < 75%		Success a. 45.45% (5/11) <50% b. Average value for the pilot =2.16% <5%	

In short, *Analysis* #4 shows that the pilot program has better performance in Budget #2, Schedule #1 and Schedule #2, even without considering the control projects utilizing Management Consultant.