

# EVALUATING THE IMPACT OF PROJECT BUNDLING ON COST PER LANE MILE FOR HIGHWAY MAINTENANCE PROJECTS

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**ABSTRACT:** Project bundling is widely believed to reduce construction costs through economies of scale and administrative efficiencies. However, these cost savings are generally perceived based on qualitative analysis and engineers' experience rather than robust statistical analysis. This study analyzes over a decade of project data from the Tennessee Department of Transportation (TDOT) to assess the impact of project bundling on Cost per Lane Mile (CPLM). The dataset includes project information for 349 bundled contracts and 1,193 unbundled contracts for maintenance projects across the state. It provides a) descriptive analysis, b) t-test for state and region level data for all project types, and c) Mann-Whitney U test for state and region level data for each treatment type. The results present a complex picture of the relationship between bundling and CPLM. The descriptive statistics shows lower CPLM for bundled projects across the state and in various regions. A statewide one-tailed t-test shows that bundling significantly reduced CPLM. However, regional-level t-tests produced mixed results, with region 2 showing statistical significance, while other regions yielded weaker or insignificant effects. The Mann-Whitney U test revealed that only two out of seven treatment types exhibited significant cost reduction associated with project bundling. These findings show that the impact of bundling is not consistent across various treatment types and geographic regions. It also highlights the need of more in-depth analysis to identify factors that significantly impact the cost savings while bundling.

## 1. INTRODUCTION

Many states Departments of Transportation (DOTs) across the U.S. has started to bundle multiple projects into a single contract to optimize resource allocation, increase competitiveness of the bid, obtain lower bids prices, reduce contract management burdens, and enhance project delivery (McCarthy, et al., 2011). The Federal Highway Administration (FHWA), Indiana DOT (INDOT), Pennsylvania DOT (PennDOT), and Missouri DOT (MoDOT) have reported various levels of success in utilizing project bundling to improve infrastructure project outcomes (Shrestha, et al., 2024). While bundling has been widely researched in the context of bridge projects, its application and impact on highway maintenance projects remain relatively underexplored. Further, research on how bundling specifically affects the cost per lane mile (CPLM) in highway maintenance projects is scarce. CPLM is a critical metric for evaluating cost efficiency in transportation infrastructure. It is used by agencies to assess budget allocations, compare project effectiveness, and determine whether cost savings are achieved through different procurement strategies. However, the relationship between bundling and CPLM is not straightforward. While some studies suggest that economies of scale lead to cost reductions, others indicate that overly large bundles could reduce competition, driving costs back up (Xiong, et al., 2017). Furthermore, treatment types (e.g., milling, resurfacing, full-depth reclamation) introduce additional variability that might affect cost outcomes independently of bundling. Given the lack of empirical research examining bundling's effect on CPLM across various treatment types, this study seeks to fill that gap. By analyzing real-world historical data from

the Tennessee DOT (TDOT), this study applies statistical methods to determine if bundling results in lower CPLM in various scenarios.

## **2. PRIOR STUDIES**

Project bundling has been widely implemented in transportation construction projects, with a primary focus on bridge rehabilitation and replacement. The FHWA and state DOTs have promoted bundling as a strategy to reduce costs, increase administrative efficiency, and accelerate project delivery (Shrestha, et al., 2024). Several state DOTs, including PennDOT, INDOT, and MoDOT, have implemented bundling practices, particularly for bridge projects, with positive results in cost reductions and streamlined contract management (Federal Highway Administration, 2022). Studies suggest that moderately sized bundles which are large enough to capture administrative and operational efficiencies but not so expansive as to deter smaller contractors often offer the most effective balance. For instance, states such as Indiana and Pennsylvania have successfully implemented such bundles in bridge and pavement projects, resulting in notable cost savings while maintaining a competitive and diverse bidder pool (Garcia & Unkefer, 2022). However, while these studies provide useful frameworks, their emphasis on bridge bundling leaves a gap in understanding the cost implications of bundling for highway maintenance projects, particularly in terms of Cost Per Lane Mile (CPLM).

### **2.1 Economic and Administrative Advantages of Bundling**

Several studies have outlined the key benefits of bundling, which generally apply across various infrastructure project types: 1) economies of scale, 2) administrative efficiency, 3) faster project delivery, and 4) consistent quality and standardization.

#### **2.1.1 Economies of Scale**

Economies of scale refer to the cost savings achieved by conducting a larger volume of work that enables contractors to lower their unit cost of work (George & Desmidt, 2018). Larger contract sizes allow for bulk procurement of materials and labor, reducing per-unit costs (D'Angelo, et al., 2019). The ability to purchase materials in bulk reduces overhead expenses, while streamlining labor costs allows contractors to optimize work schedules and equipment deployment. This effect is more pronounced in projects with similar scopes of work, where efficiencies in production and resource allocation are maximized. Additionally, economies of scale in transportation construction can lead to lower bid prices, as contractors' factor in the benefits of volume discounts and efficiency gains (Qiao, et al., 2018).

#### **2.1.2 Administrative Efficiency**

Fewer contracts result in lower administrative burdens, freeing up DOT resources for project oversight and execution (Qiao, et al., 2018). By reducing the number of contracts that DOTs need to manage, bundling minimizes paperwork, procurement processing, and oversight complexity. This efficiency is particularly beneficial in states where DOT staffing constraints limit the ability to effectively manage multiple, small-scale contracts simultaneously. The savings from reduced administrative work can be redirected toward project execution and long-term maintenance planning, allowing agencies to be more proactive in infrastructure management.

#### **2.1.3 Faster Project Delivery**

Bundled projects often move through planning and approval phases faster than individually procured projects, leading to accelerated construction schedules (Shrestha, et al., 2024). The ability to group projects under a single contract simplifies the procurement process, allowing DOTs to award multiple projects with a single bid package, reducing contract processing times. Furthermore, bundling enables simultaneous mobilization of resources, reducing delays caused by staggered project scheduling. When projects are bundled appropriately – especially in terms of geographic proximity and treatment type – they can be completed in 30 to 50% less time compared to individually managed projects (Xiong, et al., 2017).

#### 2.1.4 Consistent Quality and Standardization

Bundling allows DOTs to enforce uniform design standards, which ensures consistency across multiple projects (Xiong, et al., 2017). Standardizing project specifications, materials, and construction techniques leads to improved quality control and fewer discrepancies in project execution. DOTs benefit from streamlined contractor requirements, leading to uniformity in pavement thickness, material sourcing, and road safety features. Bundling generally enhances the ability to implement long-term performance-based specifications, which improves overall durability and reduces lifecycle maintenance costs. In states where DOTs aim for sustainable infrastructure development, bundling ensures that projects align with green construction practices and regulatory compliance frameworks.

### 2.2 Challenges and Limitations of Bundling

Despite the benefits of project bundling, it has several challenges and limitations, particularly for road maintenance projects, where variability in project scope, location, and contractor availability can impact cost savings and project efficiency. Some of these challenges include 1) potential for reduced competition, 2) complex contract management, and 3) variability in cost savings.

#### 2.2.1 Potential for Reduced Competition

Large contract sizes may discourage small and medium-sized contractors from bidding, leading to a less competitive bidding environment and potentially higher costs (Xiong, et al., 2017). When contracts become too large, smaller firms may lack the financial and technical capacity to participate, resulting in a market where only a few large contractors dominate. This could lead to less aggressive pricing and increased risk for DOTs in terms of contractor availability and service quality. Moreover, the reduction in competitive bidding can counteract some of the cost savings expected from bundling, making it necessary for DOTs to carefully assess the optimal bundle size.

#### 2.2.2 Complex Contract Management

Bundled contracts require higher levels of coordination and management expertise, which may offset some of the administrative savings (Shrestha, et al., 2024). Managing bundled projects demands a more sophisticated approach to scheduling, subcontractor management, and compliance monitoring. DOTs must ensure that all projects within a bundle progress at a synchronized pace to avoid cost overruns and delays. In cases where project locations are dispersed or where multiple stakeholders are involved, misalignment in timelines and project expectations can add further complexity. In addition, Miralinaghi, et al. (2022) found that bundled contracts can lead to public inconvenience when the grouped projects lack spatial proximity. When bundled projects are dispersed across wide geographic areas, logistical challenges such as extended detours, inconsistent traffic control measures, and resource deployment inefficiencies can disrupt local mobility and reduce the perceived benefits of bundling from a public service perspective.

#### 2.2.3 Variability in Cost Savings

The level of cost savings – resulting from project bundling – can vary depending on project scope, location, and contractor availability (D'Angelo, et al., 2019). The effectiveness of bundling is highly dependent on various factors, such as, project similarity, geographic proximity, and the types of treatments being applied. Projects that require highly specialized work or different materials may not achieve the same cost efficiencies as those with standardized treatments. Additionally, local contractor market conditions can influence whether bundling results in savings, as fewer firms competing for bundled contracts may drive prices up rather than down. For instance, Xiong, et al. (2017) estimated that the optimal contract size for achieving economies of scale and maintaining competitive bidding in bundled projects is approximately 20,000 sq ft of deck area for bridges and 10–20 lane miles for pavement contracts. Their findings suggest that bundling can be cost-effective when project size is carefully managed.

## 2.3 Research Gaps

Most empirical studies on bundling focus on bridge projects, leaving gaps in knowledge regarding highway maintenance and CPLM impacts. Studies like Xiong et al. (2017) explore how economies of scale affect unit costs, but few explicitly analyze cost-per-mile efficiency in road projects. Additionally, studies such as Assaf and Assaad (2023) investigate decision-making factors in bundling but do not provide detailed cost-benefit breakdowns for different treatment types. The FHWA Advanced Project Bundling Report identifies best practices in bundling but lacks statistical validation of cost impacts (Federal Highway Administration, 2021). Many of its findings are based on case studies and qualitative assessments, rather than rigorous quantitative analysis. Another critical limitation is the lack of standardization in measurement metrics. While cost savings are often cited as a primary benefit of bundling, many studies fail to quantify these savings consistently. Direct cost comparison between bundled and unbundled project is challenging because of the differences in contract structuring, procurement models, and project scopes. A standardized approach to measuring CPLM across different project types would improve the ability to determine whether bundling consistently leads to cost reductions. This study conducts statistical analysis, such as, t-tests and Mann-Whitney U test, to determine if bundling has significant impact on CPLM in Tennessee DOT (TDOT) maintenance projects.

## 3. RESEARCH OBJECTIVES

The primary goal of this study is to analyze the impact of bundling on CPLM in highway maintenance projects. The specific objectives of this research are to:

- evaluate if bundling significantly reduces CPLM compared to unbundled projects by analyzing historical cost data,
- examine the statistical significance of bundling's effect on CPLM using t-tests and Mann-Whitney U test to determine whether observed differences are meaningful, and
- investigate variations in bundling effectiveness across different treatment types to assess whether cost reductions are treatment specific.

## 4. METHODOLOGY

This study employs a structured methodology divided into two primary components: data collection and data analysis.

### 4.1 Data Collection

Historical project data was obtained from TDOT, covering a decade (2013 – 2023) of transportation projects. The dataset included information on project costs, lane miles, treatment types, and contract structures (bundled vs. unbundled). The project cost represents the contract amount only and does not include the contract administration costs as such administrative costs are not available for the analysis. To ensure data accuracy and reliability, a data cleaning process was conducted to remove errors and incomplete data entries. Given that project costs are influenced by economic factors such as inflation, labor demand, and material costs, adjustments were made to normalize the data. The National Highway Construction Cost Index (NHCCI) was used to derive inflation adjustment factor to account for cost fluctuations over time. The formula used for adjusting project costs for inflation is as represented in Eq. 1:

$$[1] \text{ Annual Inflation} = \left( \left( \frac{\text{NHCCI of the Latest Year}}{\text{NHCCI of the Earliest Year}} \right)^{\frac{1}{\text{Number of Years}}} - 1 \right) \times 100\%$$

The study defines bundled contracts as those containing two or more Project Identification Numbers (PINs), whereas unbundled contracts contain only one PIN. To ensure fair comparisons between bundled and unbundled projects, the PINs in each bundled contract were aggregated as a single unit rather than

evaluated as individual projects, i.e., the project costs and lane miles were added to create an equivalent larger project. For bundled projects, the CPLM was calculated using Eq. 2.

$$[2] CPLM = \frac{\text{Total Project Cost}}{\text{Total Lane Miles}}$$

After completing data processing, the final dataset included 349 bundled contracts and 1193 unbundled contracts, spanning over 100 different treatment types.

## 4.2 Data Analysis

The statistical analysis employed t-test and Mann-Whitney U test using Minitab. Both tests are widely used to compare differences between groups and determine statistical significance.

### 4.2.1 T-Test Analysis

A t-test is a statistical test used to compare the means of two groups and determine whether the difference between them is statistically significant. In this study, the t-test was used to evaluate whether the average CPLM of bundled projects was significantly different from that of unbundled projects. A statewide t-test was conducted as an initial high-level overview of bundling's impact on project costs. Additional regional t-tests were performed to determine if the bundling effect varied geographically. Unlike a two-tailed t-test, which tests for any significant difference (higher or lower), a one-tailed t-test was chosen because the research objective is to evaluate whether bundling significantly reduces CPLM.

The test was conducted using the following approach:

- Null Hypothesis ( $H_0$ ): There is no significant difference in CPLM between all bundled and unbundled projects at the statewide and regional levels disregarding treatment types.
- Alternative Hypothesis ( $H_1$ ): The CPLM for bundled projects is lower than the CPLM for all unbundled projects at the statewide and regional levels disregarding treatment types.

A valid t-test requires that:

- The data approximately follows a normal distribution (though t-tests are relatively robust to violations of this assumption for large sample sizes).
- The two groups have independent observations (i.e., bundling status is independent for each project).
- Variance between the two groups may be equal (in a pooled t-test) or unequal (in a Welch's t-test, which was used in this study).
- The p-value obtained from the t-test indicates whether the observed difference is statistically significant. A p-value below 0.05 suggests strong evidence that bundling has a meaningful effect on CPLM.

Due to limited sample sizes at more granular levels, Mann-Whitney U test for top treatment types statewide were conducted. The selection criteria required that treatment types contain at least seven bundled and seven unbundled contracts to ensure a meaningful statistical comparison.

### 4.2.2 Mann-Whitney U Test

The Mann-Whitney U test, also known as the Wilcoxon Rank-Sum test, is a non-parametric statistical test used to compare two independent groups when the assumption of normality is violated or when sample sizes are small. Since filtering the data by treatment type resulted in smaller sample sizes, a t-test was no longer appropriate. Instead, the Mann-Whitney U test was used to determine whether there was a significant difference in CPLM between bundled and unbundled projects within specific treatment types.

The test was conducted using the following approach:

- Null Hypothesis ( $H_0$ ): There is no difference in the distribution of CPLM between bundled and unbundled contracts within a given treatment type.
- Alternative Hypothesis ( $H_1$ ): There is a significant difference in the distribution of CPLM between bundled and unbundled contracts within a given treatment type.

Since the Mann-Whitney U test compares medians rather than means, it is robust to outliers and skewed data distributions. The significance level was set at 0.05, with p-values below this threshold indicating a statistically significant difference between bundled and unbundled CPLM values for specific treatment types.

## 5. RESULTS

The analysis conducted in this study provides a comprehensive evaluation of the impact of bundling on the CPLM. The results include descriptive statistics, statewide and regional t-tests for all treatment types, and Mann-Whitney U tests for each treatment types.

### 5.1 Descriptive Statistics

The dataset consists of 349 bundled contracts and 1,193 unbundled contracts spanning over 100 different treatment types. Table 1 summarizes the descriptive statistics for bundled and unbundled contracts across the state and different regions.

The key observations from the table are as follows:

- Across all regions, the mean CPLM for bundled contracts (\$136,730.94) was lower than that for unbundled contracts (\$161,474.51). This trend is consistent across all four regions, with bundled projects showing lower mean CPLM values.
- The median CPLM values follow the same trend as the mean, where bundled projects generally exhibit lower values than unbundled ones. For example, in region 2, the median CPLM for bundled projects is \$103,733.89, whereas for unbundled projects, it is \$144,693.19.
- Based on the standard deviations (St. Dev), the bundled projects have more consistent CPLM than unbundled projects.
- There are 3 to 4 times more unbundled projects compared to bundled projects statewide as well as in each region.

Table 1: Descriptive Statistics for all Bundled and Unbundled Contracts

Location	Bundling	Mean	Median	St. Dev	Count
Statewide	Bundled	\$136,730.94	\$120,250.26	\$88,165.25	349
	Unbundled	\$161,474.51	\$132,537.81	\$116,657.90	1193
Region 1	Bundled	\$136,260.58	\$122,830.77	\$81,479.27	83
	Unbundled	\$158,591.96	\$123,969.60	\$115,941.83	256
Region 2	Bundled	\$126,487.22	\$103,733.89	\$102,837.05	113
	Unbundled	\$169,301.55	\$144,693.19	\$146,006.24	296
Region 3	Bundled	\$122,748.21	\$104,966.69	\$65,122.77	95
	Unbundled	\$138,411.42	\$113,362.68	\$93,081.82	407
Region 4	Bundled	\$179,169.10	\$182,253.74	\$88,494.41	58
	Unbundled	\$195,006.93	\$183,870.05	\$103,080.60	234

The lower mean CPLM for bundled contracts suggests that bundling may be associated with cost savings, at least at a high-level comparison. However, the higher variability in unbundled project costs implies that unbundled projects may include both very high-cost and low-cost projects, while bundled projects maintain more stable cost levels. The larger sample size of unbundled contracts may indicate that bundling is not as commonly used across all project types or regions. These descriptive statistics provide an initial foundation for further statistical testing, such as t-tests and Mann-Whitney U test, to determine whether these differences are statistically significant and whether bundling contributes to reducing CPLM.

## 5.2 T-Test Results

To assess whether bundling has a statistically significant impact on CPLM, independent t-tests were conducted comparing bundled and unbundled projects at both the statewide and regional levels. The t-test is used to determine whether the mean CPLM of bundled contracts is significantly different from that of unbundled contracts. Given the descriptive statistics, which indicate that bundled contracts have a lower mean CPLM than unbundled contracts, the t-test helps establish whether these differences are statistically significant or if they could have occurred due to random variation. Table 2 summarizes the t-test results for bundled and unbundled contracts across the state and different regions.

Key observations are as follows:

- The t-statistic of -4.30 and p-value of 0.00001 strongly indicate that bundling significantly reduces CPLM when considering all projects at the state level.
- Region 2 is highly significant (t = -3.33, p = 0.0005), reinforcing that bundling has a strong impact on reducing CPLM in this region.
- Regions 1 and 3 also have significant results (Region 1: t = -1.94, p = 0.027; Region 3: t = -1.93, p = 0.028), indicating that bundling reduces CPLM in these regions as well. Though the effect size appears smaller than in region 2, the results still support bundling as a cost-saving measure.
- Region 4 is not statistically significant (p = 0.121), meaning the data does not provide strong evidence that bundling reduces CPLM in this region. Smallest sample size (DF = 99) could be a limiting factor in detecting statistical significance.

Table 2: T-test results for all contracts Statewide and Regionally

Location	Degree of Freedom (DF)	T Statistic	P Value
Statewide	738	-4.30	0.00001
Region 1	197	-1.94	0.027
Region 2	286	-3.33	0.0005
Region 3	194	-1.93	0.028
Region 4	99	-1.18	0.121

The results suggest that bundling may work differently across regions. This suggests that regional factors such as contractor availability, project scope, and bidding environments may influence the cost-effectiveness of bundling. This raises the need for further investigation into whether specific project characteristics (such as treatment types) influence the effectiveness of bundling. The next phase of analysis will use the Mann-Whitney U test, filtering by treatment types, to determine if specific treatment type experience cost savings from bundling.

## 5.3 Mann-Whitney U Test Results

While the t-test provided insights into CPLM differences between bundled and unbundled contracts at the statewide and regional levels, further granularity was required to assess the impact of bundling on specific treatment types. However, as filtering the contracts by treatment type significantly reduced sample sizes, the assumption of normality becomes invalid, and hence t-test is as appropriate for the analysis. To address this, the Mann-Whitney U test was employed. A one-tailed test was used to evaluate whether CPLM for bundled contracts was lower than for unbundled contracts within a given treatment type statewide. Since there is a large number of treatment types (100), the analysis was narrowed down to top 7 treatment types in terms of the project count. Table 3 summarizes the Mann-Whitney U test. Key observations are as follows:

- The majority of treatment types tested do not show a statistically significant difference in CPLM between bundled and unbundled projects.
- However, for Profile Mill & 411TLD @85lb/sy and Hot-in-place recycling with 411TLD, bundling appears to significantly impact CPLM.
- Mill & 411D, despite having one of the highest sample sizes, also failed to reach significance ( $p = 0.807$ ), indicating no clear effect of bundling.

Table 3: Mann-Whitney U test results.

Treatment Type	Bundling	Mean	Median	St. Dev	Count	p-value
411D	Bundled	\$129,534.11	\$126,636.72	\$31,431.49	45	0.501
	Unbundled	\$132,003.73	\$124,243.13	\$38,846.87	104	
411TLD @85lb/sy	Bundled	\$104,848.72	\$93,117.38	\$38,962.53	48	0.974
	Unbundled	\$92,738.69	\$85,910.57	\$37,807.14	134	
411TLD @65lb/sy	Bundled	\$75,084.89	\$66,344.73	\$23,343.43	11	0.452
	Unbundled	\$76,192.40	\$78,856.74	\$26,327.44	22	
Microsurfacing @22lb/sy	Bundled	\$39,238.42	\$38,757.09	\$9345.70	37	0.319
	Unbundled	\$43,396.50	\$38,970.18	\$16,040.60	33	
Hot-in-place recycling with 411TLD	Bundled	\$202,695.82	\$178,436.64	\$77,410.02	7	0.037
	Unbundled	\$219,570.37	\$211,135.46	\$34,391.85	19	
Profile Mill & 411TLD @85lb/sy	Bundled	\$70,508.75	\$73,641.53	\$12,015.17	8	0.0013
	Unbundled	\$96,309.24	\$91,735.37	\$29,435.38	51	
Mill & 411D	Bundled	\$184,651.46	\$170,864.81	\$88,607.14	113	0.807
	Unbundled	\$178,383.87	\$155,624.62	\$88,126.08	463	

## 6. DISCUSSIONS

The findings of this study provide preliminary evidence that bundling highway maintenance projects may lead to lower Cost per Lane Mile (CPLM), especially at the statewide level and in select regions. However, there are several important points that should be considered when interpreting these results.

1. The t-test results done at a high level (statewide and in most regions) support the hypothesis that bundling reduces CPLM. The Mann-Whitney U test results, however, do not confirm a strong bundling effect across treatment types, which suggests that the observed differences in the t-test might not hold across all contract types. The inconsistency in statistical significance across different tests suggests that while bundling may reduce CPLM in certain cases, it is not a universally effective cost-reduction strategy across all treatment types and locations. The lack of statistical significance in many cases could be due to small sample sizes when filtering by treatment type, indicating a need for larger datasets or alternative grouping methods.
2. This study only considers the direct contract costs from bid awards, and it ignores the administration costs, such as, contract management, design, permitting, inspection, and DOT personnel labor. These indirect costs could vary substantially between bundled and unbundled projects, which could potentially

influence the overall impact of bundling on the CPLM. For future research, these administrative costs should be considered for more comprehensive analysis of the impact of bundling on CPLM.

3. Selection bias could be present if bundled projects were systematically different from unbundled ones in terms of complexity, urgency, or funding source. For example, projects that are simpler in scope or located near one another might be more likely to be bundled, while high-priority or emergency repairs may be executed as standalone contracts. These underlying differences could complicate the relationship between bundling and cost, which makes it more challenging to attribute observed cost savings solely to the bundling strategy itself.
4. While this study focuses on highway maintenance projects, some of the findings may extend to other types of projects, including widening, reconstruction, and new construction. The benefits associated with bundling, such as, cost reductions through economies of scale and reduced administrative effort are not unique to pavement maintenance and can should be applicable to other project types.
5. Finally, this study analyzes historical data from a single state (Tennessee), and hence the results may not be generalizable for other states with different procurement practices and local competition.

## 7. CONCLUSIONS

This study conducted statistical analysis (t-tests, and Mann-Whitney U tests) to evaluate if project bundling reduces Cost per Lane Mile (CPLM) in highway maintenance projects. The results present a complex picture of the relationship between bundling and project costs. At the statewide level, a one-tailed t-test indicated that bundling significantly reduced CPLM ( $p = 0.00001$ ), supporting the hypothesis that bundling leads to cost savings. When projects were filtered by treatment type, the Mann-Whitney U test was used due to smaller sample sizes. The results showed that in most treatment types, there was no statistically significant difference in CPLM between bundled and unbundled contracts. While this study does not provide a definitive conclusion that bundling always reduces CPLM, it highlights potential benefits at higher aggregation levels and the need for further investigation into treatment-specific cost impacts.

## 8. ACKNOWLEDGEMENT

The researchers would like to thank the Tennessee Department of Transportation (TDOT) and its staff members for funding this study (RES2024-08), providing valuable data, and providing insights about their current bundling practices.

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