

ARIZONA DEPARTMENT OF TRANSPORTATION PROJECT DELIVERY CYCLE TIME ANALYSIS

Final Report 518

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16. Abstract The Arizona Department of Transportation (ADOT) conducted research to quantify project delivery cycle time. The purpose of this research was to compare ADOT with other state departments of transportation. This research found that there are significant challenges in establishing measures of project delivery cycle time from data in ADOT's various information systems. These challenges limited the ability of the research to provide a meaningful comparison with other states. The principal recommendation from the study was the need to determine standardized procedures across all ADOT program areas for establishing project schedule baselines and for recording information on accomplishments and project durations.					
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
<u>LENGTH</u>					<u>LENGTH</u>				
in	Inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	Feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	Yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	Miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
<u>AREA</u>					<u>AREA</u>				
in ²	square inches	645.2	square millimeters	mm ²	mm ²	Square millimeters	0.0016	square inches	in ²
ft ²	square feet	0.093	square meters	m ²	m ²	Square meters	10.764	square feet	ft ²
yd ²	square yards	0.836	square meters	m ²	m ²	Square meters	1.195	square yards	yd ²
ac	Acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi ²	square miles	2.59	square kilometers	km ²	km ²	Square kilometers	0.386	square miles	mi ²
<u>VOLUME</u>					<u>VOLUME</u>				
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	Gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft ³	cubic feet	0.028	cubic meters	m ³	m ³	Cubic meters	35.315	cubic feet	ft ³
yd ³	cubic yards	0.765	cubic meters	m ³	m ³	Cubic meters	1.308	cubic yards	yd ³
NOTE: Volumes greater than 1000L shall be shown in m ³ .									
<u>MASS</u>					<u>MASS</u>				
oz	Ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	Pounds	0.454	kilograms	kg	kg	kilograms	2.205	pounds	lb
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")	Mg (or "metric ton")	megagrams (or "metric ton")	1.102	short tons (2000lb)	T
<u>TEMPERATURE (exact)</u>					<u>TEMPERATURE (exact)</u>				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C	°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
<u>ILLUMINATION</u>					<u>ILLUMINATION</u>				
fc	foot candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²	cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
<u>FORCE AND PRESSURE OR STRESS</u>					<u>FORCE AND PRESSURE OR STRESS</u>				
lbf	Poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380

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EXECUTIVE SUMMARY

This report presents the results of an analysis to establish baseline measures of project development cycle times at the Arizona Department of Transportation (ADOT). It also presents a benchmarking study that surveyed cycle times in other states; the study was used to compare ADOT cycle times to a national standard. This report closes with the conclusions from the cycle time analysis and recommendations for ADOT to achieve best practice in its management of project delivery cycle times.

ADOT CYCLE TIME ANALYSIS

The general approach to identifying and calculating cycle time used data drawn from three separate databases of project information at ADOT: the Priority Programming System (PPS), the Primavera Project Planner (P3), and Advantage, which is ADOT's financial management system.

Based on the information available, the following measures were calculated as indicators of cycle times:

- Number of days between the start of scoping and the bid advertisement.
- Number of days between the date when a scoping document was requested and the bid advertisement date.
- Number of days between the first charges made against the project and the date it was advertised for construction.

Of the 17 different types of projects categorized by ADOT, the following five were chosen for analysis: Bridge, District Minor (those funded from district lump sum sub-program accounts), Major (more than \$3 million), Minor (less than \$2 million), and Pavement Preservation.

Findings are somewhat limited in applicability because:

- Cycle time measurements are skewed by unrecorded work stoppages.
- Information was collected from three distinct databases, and these databases have little connection with each other.
- More than 50 percent of the projects in the study population were not included in the analysis because of lack of data items required to compute the indicators.
- ADOT district offices provided cost estimates, and supplemented project award values and dates on some projects. Several of the selected projects did not have data for the amount awarded for the winning bid.

BENCHMARKING STUDY WITH OTHER STATE DEPARTMENTS OF TRANSPORTATION

To perform a benchmarking study with other state departments of transportation, representatives from the following organizations were contacted:

- Massachusetts Highway Department (MassHighway).
- Minnesota Department of Transportation (Mn/DOT).
- Montana Department of Transportation (MDT).
- Michigan Department of Transportation (MDOT).
- New Jersey Department of Transportation (NJDOT).
- New Mexico Department of Transportation (NMDOT).
- Utah Department of Transportation (UDOT).
- Washington State Department of Transportation (WSDOT).

These representatives were queried as to whether their agencies had conducted cycle time analysis and, if so, whether they had data available. In addition, this study relied on experience that Dye Management Group, Inc. has accumulated in conducting preconstruction analysis on past projects.

When looking at benchmarking data, it is important to remember that the definitions of start and end vary between states, projects are categorized according to different definitions in different states, and the time period covered varies between states.

We found that a majority of state departments of transportation do not keep track of project cycle time. Many of the states re-baseline projects; that is, when delays arise, the original schedule is shifted out to compensate for the delay. Under this procedure, project start dates are not maintained, so determining the actual cycle times is impossible.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Following are the conclusions based on the results of the cycle time analysis:

- There is some indication that ADOT's more complex projects are not taking longer than similar projects in other states; however, pavement preservation projects are taking longer.

- Rework is a major factor in delay. Rework results from poor communication, lack of district involvement early in the design phase, limited ability to “lock in” scope changes due to the permitting process, and lack of early quality control to identify issues.
- Environmental and right-of-way activities could start earlier. Best practice analysis indicates that other states are starting environmental and right-of-way activities earlier in the process.
- There is not enough standardization of project management procedures, approaches, and designs. Best practices are moving towards more standardization.
- There is a lag between pre-design and design. The time between identification of a project need and the beginning of design work adds to cycle time.

Recommendations

The recommendations outlined below are based on the research performed through the cycle time analysis and on information developed for the best project management practices study:

- Monitor and report project cycle time. This requires the establishment of an agreed measure of cycle time. Accurate cycle time data make it possible to identify trends and provide opportunities for improvement.
- Establish project duration standards by project type.
- Address the disconnect between the scoping process and design. This can be done in one of the following two ways:
 - Option 1. Make project managers responsible for scoping using the pre-design group expertise as a technical resource.
 - Option 2. Reengineer the pre-design and scoping processes.
- Establish a cycle time baseline and an agenda for action to reduce cycle time.
- Identify and address bottlenecks. Bottlenecks are often caused by local government agreements, approval of consultant work scopes, and final plan checking processes. Work groups can be convened to identify process bottlenecks.

INTRODUCTION

This report presents the results of an analysis to establish baseline measures of project development cycle times at ADOT. It also presents a benchmarking study that surveyed the cycle times at other states to compare these with the existing cycle times at ADOT. The document closes with conclusions from the analysis and recommendations for ADOT to move forward in achieving best practices in project cycle time management.

The first section contains a discussion of actual cycle times at ADOT. The analysis focused on determining the number of days between the time that projects are scoped during pre-design to the time they are actually advertised for bidding.

The second section contains a benchmarking study that examines the cycle times in other states to determine where ADOT fits into the national spectrum of project delivery. The benchmarking study looked at seven states. Based on a close analysis of the available data, four of these states were selected for a more detailed study in order to furnish a benchmarking standard.

The third section contains the cycle time analysis conclusions and recommendations. The conclusions explain how well ADOT is doing compared to nationwide cycle times. The recommendations point to a direction for ADOT to take in improving cycle times for project delivery.

ADOT CYCLE TIME ANALYSIS

This section presents the results of an analysis to establish baseline measures of project development cycle times at ADOT. Specifically, these measures show how many days pass between the date projects are scoped during pre-design and the date they are advertised for bidding to construct, and between the date initial work is charged by ADOT and the date this work is advertised for bidding to construct. The analysis excluded some project types, including MAG Life Cycle projects.

The general approach to identifying and calculating cycle time measurements of construction projects involved the following steps:

- Analyze- available databases including the P3 and the PPS.
- Acquire- a copy of the data dictionary for the PPS database.
- Evaluate- data fields and determined which fields were most useful to use for conducting the analysis.
- Request that ADOT run a query of the PPS database for a specific set of projects over a specific period.
- Work with the project scheduling office to derive data from ADOT's financial management system (Advantage) regarding the day work began.
- Calculate cycle times for five project category types.

CYCLE TIME MEASURES

As part of the initial assessment and data collection efforts for this analysis, the following measures were suggested for identifying the cycle times for development and delivery of projects prior to construction:

- Number of days between completion of pre-design work and letting (the time when the design consultant is under contract).
- Number of days between a project entering the program and letting.
- Number of days between expenditure charged to the project (once in the program) and letting.

Three separate databases of project information at ADOT were utilized to determine these measures:

- Priority Programming System (PPS) – Maintains project activity information for providing project status that is useful for management and for the public through the ADOT Web site.
- Primavera Project Planner (P3) – ADOT’s project scheduling system for maintaining the schedule of milestones and activities associated with individual projects. The data provided from P3 only indicated when the schedule for each project was entered into the system, not when activities related to project cycle time occurred.
- Advantage – ADOT’s financial management system for tracking labor and material expenditures is useful for identifying when work was completed on projects. Data on when expenditures for specific job functions are charged against projects, are maintained within the system.

Based on the information available and collected from these systems, the following measures were calculated as indicators of cycle time:

- Number of days between the date scoping began on a project and the date it was advertised for construction.
- Number of days between the date the project was requested and the bid advertisement date as recorded in the PPS database.
- Number of days between the date on which expenditure was first charged to a programmed project and the date it was advertised for construction.

Measurement Issue

The approach to measuring cycle time once projects are in the 5-Year Program does not address an issue raised at the outset of this project: projects have entered and left the program, or have been combined, increasing cycle time. Our data use, as the starting point, the first charges that were incurred against the project identification number in the PPS database for the project that was advertised. Without tracking backwards individually for projects, we were unable to deal with situations in which projects were combined for letting, entered the 5-Year Program under one number, dropped out, and then re-entered.

SPECIFIC ANALYSIS STEPS

The specific approach for collecting and analyzing project delivery data involved the following:

1. Collecting project activity data using ADOT's PPS data warehouse for a sample of projects let between May 1, 2001, and April 30, 2002. The number of projects available totaled 167. Project activity data that were chosen included the following key fields:
 - TRACS Number: The data field used for tracking the status of an individual project.
 - Project ID: The unique identification number used for managing and tracking capital projects.
 - Project Category: The type of project as defined by ADOT. ADOT has categorized 17 different types of projects. Of these, the following project types were included:
 - Bridge – This type of project involves roadway engineering work that is specific to bridges and bridge structures, such as deck repairs and replacements, and joint repairs, among others.
 - District Minor – This type of project includes projects specifically funded out of district lump sum sub-program accounts. Projects are selected by the district.
 - Major – This type of project provides significant capacity improvements and includes other significant projects, such as traffic interchanges, climbing/passing lanes, and ITS projects. Values of projects are typically greater than \$3 million.
 - Minor – Similar to major projects, but project values are generally less than \$2 million.
 - Pavement Preservation – This type of project involves work to preserve or recondition roadway surfaces. The type of work is generally limited to removal and replacement, mill and replacement, overlay, or the sealing of pavement surfaces.
2. Requesting that ADOT staff query data within the financial management system to determine when the first labor or material charges were recorded for individual projects. Initial Expenditure, the date defined as the point when a project is considered programmed and entered into the 5-Year Program, was collected for each project in this analysis.

3. Calculating the number of days between the date requested and the bid advertisement date, and between initial expenditure and the bid advertisement date.
4. Reviewing and assessing data from 167 projects:
 - Of these 167 projects, 54 projects with the following category types were eliminated: Intermediate, MAG Life Cycle, Roadside Improvement, Safety, State Park Roads, and Statewide Program. These projects were excluded because they do not lend themselves well to comparison with other states. Of the remaining 113, those projects without data for Date Requested or Initial Expenditure were eliminated from the analysis. Once all projects with insufficient data were cut from the data group, there remained:
 - Forty projects available for the cycle time measure from date requested to bid advertisement date.
 - Ninety-five projects available for the cycle time measure from date of initial expenditure to bid advertisement date.

RESULTS OF ANALYSIS

The figures and tables below illustrate the projects with valid data present in the PPS and financial management system that yielded calculated results for the two performance measures for cycle time.

Bridge Projects

Figure 1 illustrates the length of project development, in days, between the dates scoping was requested for six bridge projects and the dates the projects were advertised for construction. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the six projects. Table 1 contains the data for Figure 1.

Figure 1: Bridge Projects – Bid Award Value, and Days Between Scoping Request and Project Advertisement (May 2001–April 2002)

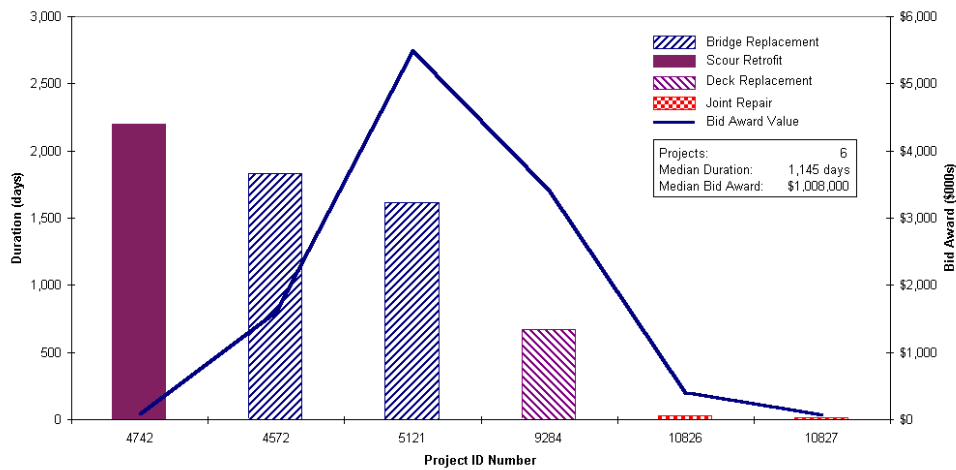


Table 1: Data for Figure 1

Project ID	Duration (days)	Bid Award (\$000s)
4742	2,201	\$91
4572	1,830	\$1,611
5121	1,618	\$5,501
9284	671	\$3,423
10826	32	\$404
10827	15	\$69

Figure 2 illustrates the length of project development, in days, between the dates labor or material charges accrued to 16 projects (from ADOT’s Advantage system) and the dates the projects were advertised for construction. It was possible to calculate the length of project development for 16 projects. The figure shows the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for the 16 projects. Table 2 contains the data for Figure 2.

Figure 2: Bridge Projects – Bid Award Value, and Days Between First Date of Project Charges and Advertisement Date (May 2001–April 2002)

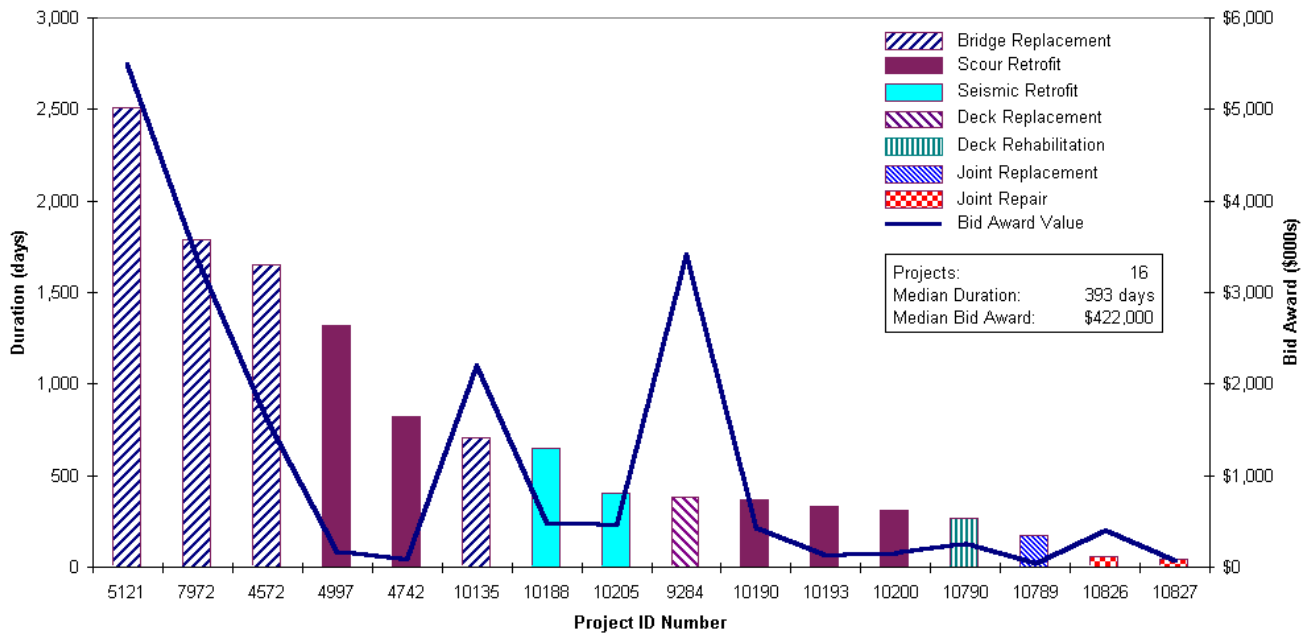


Table 2: Data for Figure 2

Project ID	Duration (days)	Bid Award (\$000s)	Project ID	Duration (days)	Bid Award (\$000s)
5121	2,513	\$5,501	9284	380	\$3,423
7972	1,789	\$3,377	10190	368	\$440
4572	1,649	\$1,611	10193	334	\$125
4997	1,323	\$179	10200	313	\$155
4742	820	\$91	10790	265	\$255
10135	705	\$2,200	10789	176	\$49
10188	649	\$497	10826	60	\$404
10205	406	\$465	10827	43	\$69

District Minor and Minor Projects

Figure 3 illustrates the length of project development, in days, between the dates scoping was requested for six District Minor and Minor projects and the dates the projects were advertised for construction. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the six projects. Table 3 contains the data for Figure 3.

Figure 3: District Minor/Minor Projects – Bid Award Value, and Days Between Scoping Request and Project Advertisement (May 2001–April 2002)

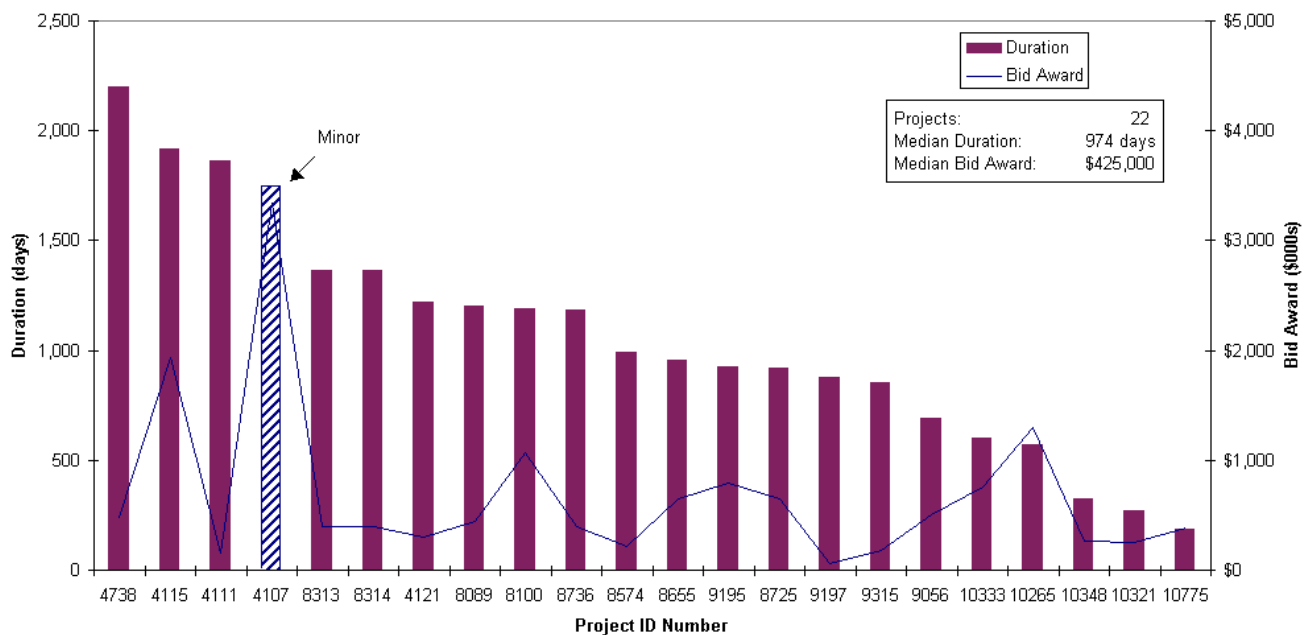


Table 3: Data for Figure 3

Project ID	Duration (days)	Bid Award (\$000s)	Project ID	Duration (days)	Bid Award (\$000s)
4738	2,201	\$482	8655	955	\$652
4115	1,916	\$1,932	9195	923	\$794
4111	1,861	\$156	8725	920	\$652
4107	1,747	\$3,344	9197	876	\$62
8313	1,362	\$400	9315	854	\$180
8314	1,362	\$400	9056	694	\$503
4121	1,217	\$300	10333	600	\$757
8089	1,202	\$450	10265	569	\$1,293
8100	1,187	\$1,070	10348	326	\$267
8736	1,186	\$400	10321	272	\$250
8574	992	\$213	10775	186	\$389

Figure 4 illustrates the length of project development, in days, between the date labor or material charges accrued to the 28 District Minor and Minor projects (from ADOT’s Advantage system) and the date the projects were advertised for construction. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for the 28 projects. Table 4 contains the data for Figure 4.

Figure 4: District Minor/Minor Projects – Bid Award Value, and Days Between First Date of Project Charges and Advertisement Date (May 2001–April 2002)

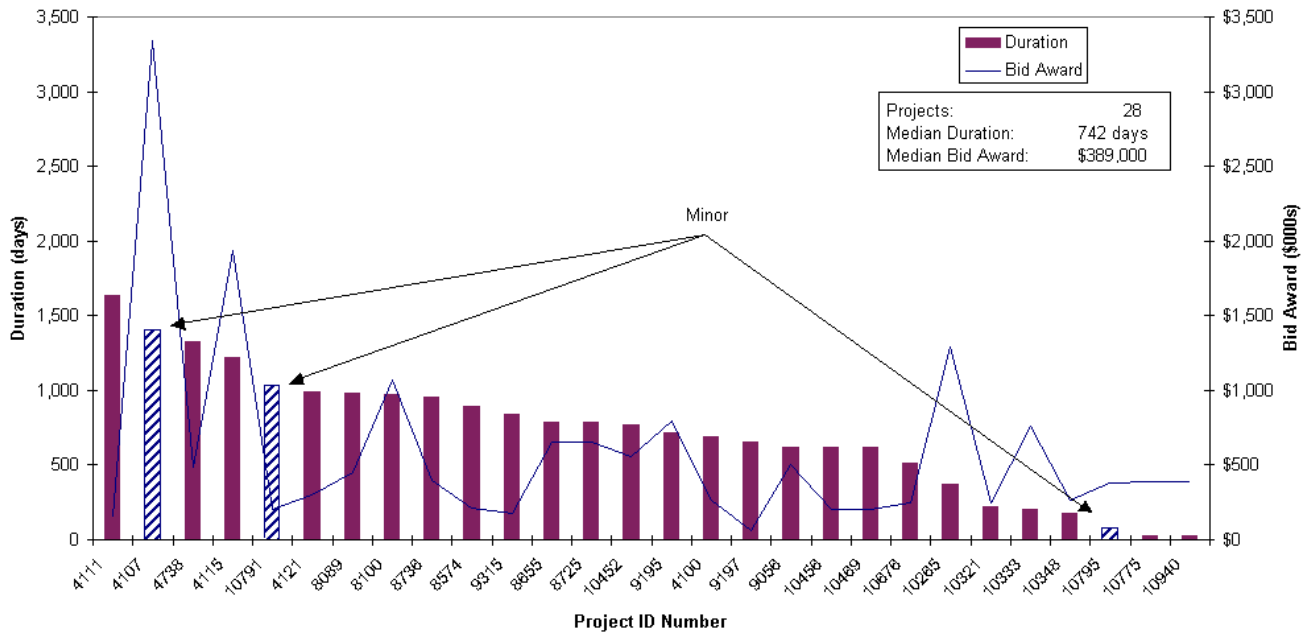


Table 4: Data for Figure 4

Project ID	Duration (days)	Bid Award (\$000s)	Project ID	Duration (days)	Bid Award (\$000s)
4111	1,637	\$156	9195	712	\$794
4107	1,401	\$3,344	4100	686	\$265
4738	1,323	\$482	9197	651	\$62
4115	1,218	\$1,932	9056	615	\$503
10791	1,032	\$207	10456	615	\$200
4121	986	\$300	10489	615	\$200
8089	982	\$450	10676	511	\$247
8100	973	\$1,070	10285	372	\$1,293
8736	955	\$400	10321	222	\$250
8574	891	\$213	10333	207	\$757
9315	843	\$180	10348	178	\$267
8655	785	\$652	10795	82	\$377
8725	785	\$652	10775	29	\$389
10452	771	\$557	10940	29	\$389

Major Projects

Figure 5 illustrates the length of project development, in days, between the dates scoping was requested for a nine Major projects and the dates the projects were advertised for construction. . The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the nine projects. Table 5 contains the data for Figure 5.

Figure 5: Major Projects – Bid Award Value, and Days Between Scoping Request and Project Advertisement (May 2001–April 2002)

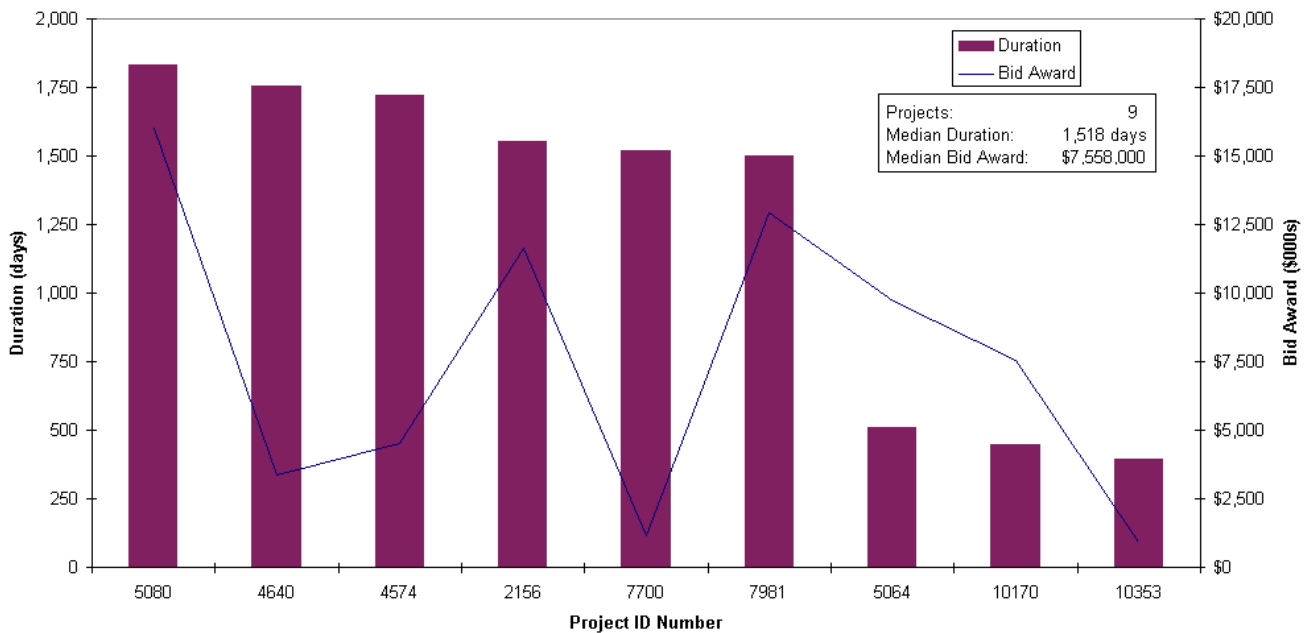


Table 5: Data for Figure 5

Project ID	Duration (days)	Bid Award (\$000s)	Project ID	Duration (days)	Bid Award (\$000s)
5080	1,830	\$16,000	7981	1,499	\$12,930
4640	1,757	\$3,344	5064	510	\$9,727
4574	1,723	\$4,525	10170	449	\$7,558
2156	1,554	\$11,656	10353	394	\$900
7700	1,518	\$1,154			

Figure 6 illustrates the length of project development, in days, between the dates scoping was requested for 13 Major projects and the dates the projects were advertised for construction. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the 13 projects. Table 6 contains the data for Figure 6.

Figure 6: Major Projects – Bid Award Value, and Days Between First Date of Project Charges and Advertisement Date (May 2001–April 2002)

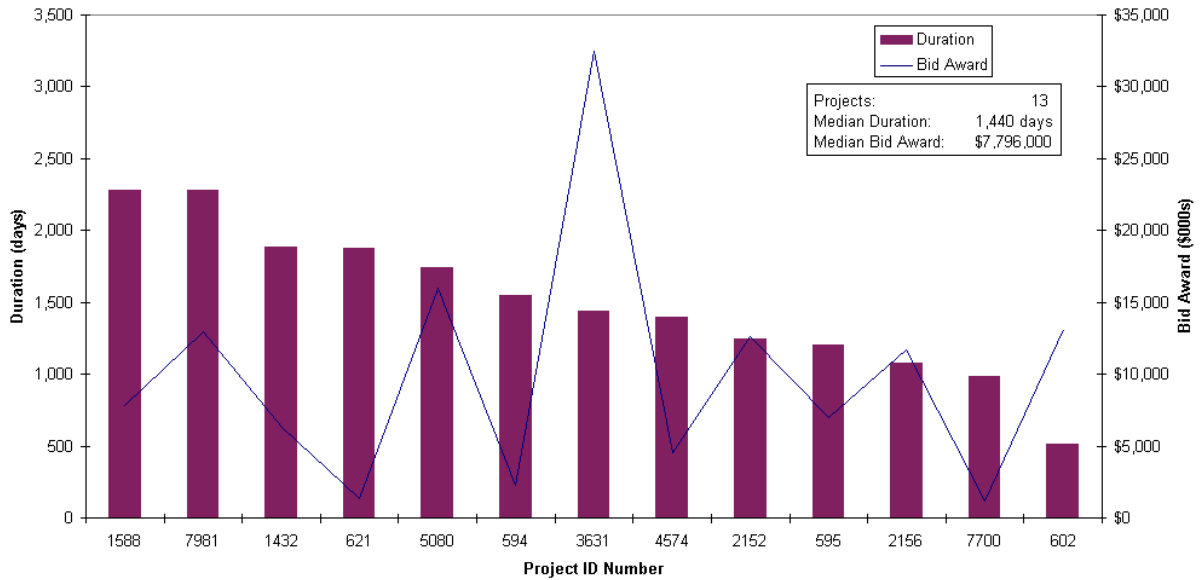


Table 6: Data for Figure 6

Project ID	Duration (days)	Bid Award (\$000s)
1588	2,284	\$7,796
7981	2,283	\$12,930
1432	1,883	\$6,295
621	1,875	\$1,330
5080	1,744	\$16,000
594	1,547	\$2,260
3631	1,440	\$32,500
4574	1,400	\$4,525
2152	1,246	\$12,625
595	1,207	\$7,000
2156	1,075	\$11,656
770	986	\$1,154
602	511	\$13,117

Pavement Preservation Projects

Figure 7 illustrates the length of project development, in days, between the dates scoping was requested for three Pavement Preservation projects and the dates the projects were advertised for construction. It was possible to calculate the length of project development for only three Pavement Preservation projects. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the three projects. Table 7 contains the data for Figure 7.

Figure 7: Pavement Preservation Projects – Bid Award Value, and Days Between Scoping Request and Project Advertisement (May 2001–April 2002)

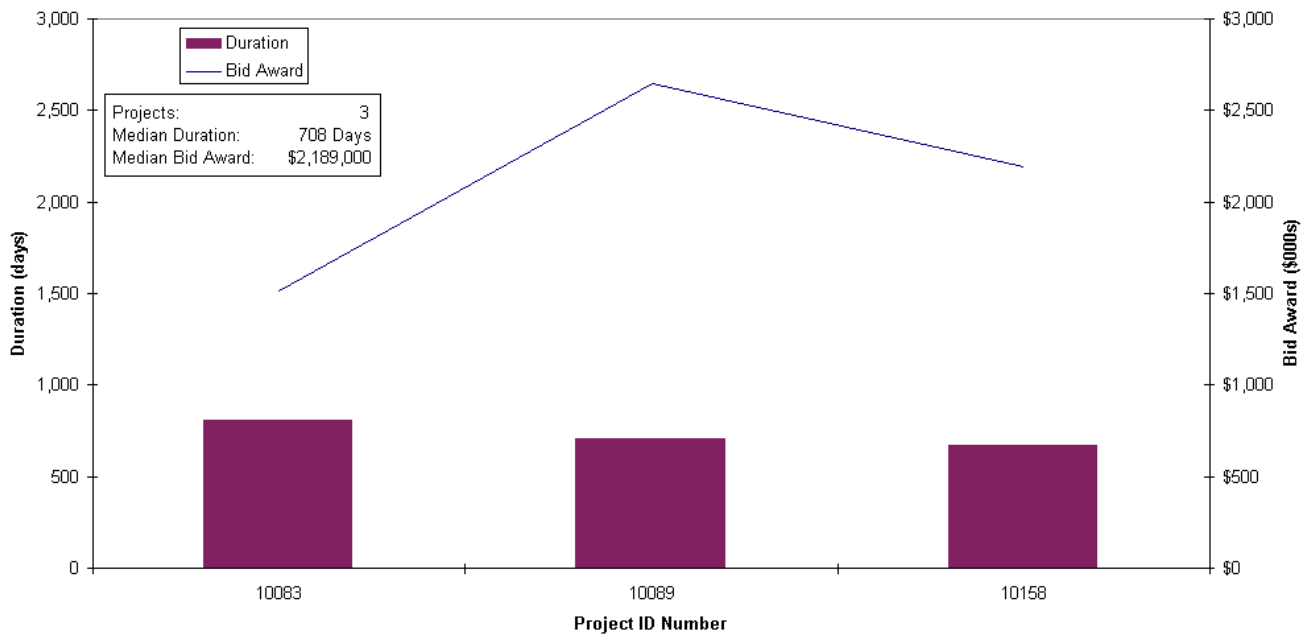


Table 7: Data for Figure 7

Project ID	Duration (days)	Bid Award (\$000s)
10083	811	\$1,512
10089	708	\$2,645
10158	671	\$2,189

Figure 8 illustrates the length of project development, in days, between the dates scoping was requested 38 Pavement Preservation projects and the dates the projects were advertised for construction. It was possible to calculate the length of project development for. The figure lists the projects by longest to shortest duration. In addition, the figure shows the value of the bid award for each of the 38 projects. Table 8 contains the data for Figure 8.

Figure 8: Pavement Preservation Projects – Bid Award Value, and Days Between First Date of Project Charges and Advertisement Date

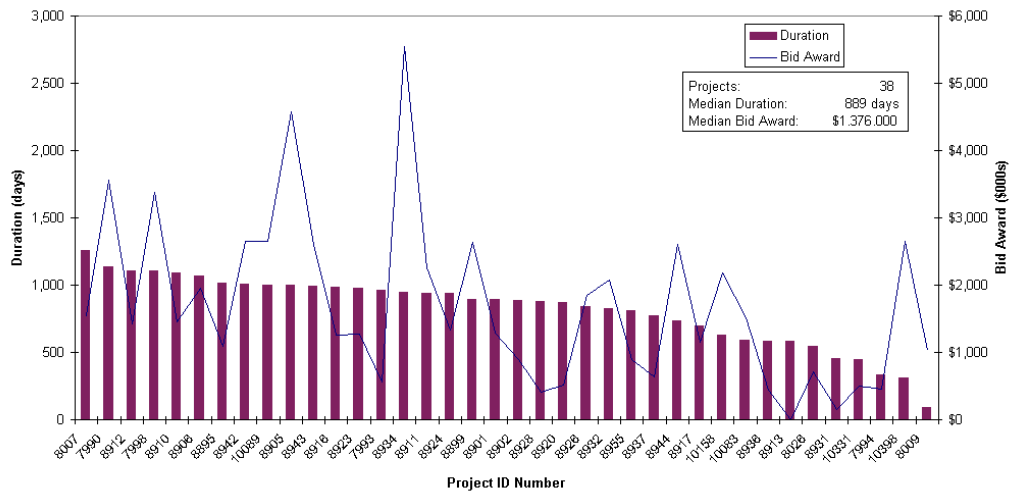


Table 8: Data for Figure 8

Project ID	Duration (days)	Bid Award (\$000s)	Project ID	Duration (days)	Bid Award (\$000s)
8007	1,257	\$1,542	8902	886	\$898
7990	1,140	\$3,564	8928	880	\$406
8912	1,106	\$1,422	8920	869	\$519
7998	1,104	\$3,377	8926	839	\$1,846
8910	1,089	\$1,448	8932	828	\$2,074
8906	1,071	\$1,949	8955	811	\$900
8895	1,016	\$1,098	8937	771	\$630
8942	1,007	\$2,654	8944	734	\$2,611
10089	1,000	\$2,645	8917	700	\$1,157
8905	999	\$4,577	10158	629	\$2,189
8943	992	\$2,611	10083	593	\$1,512
8916	982	\$1,265	8936	586	\$434
8923	974	\$1,268	8913	584	\$0
7993	965	\$556	8026	547	\$709
8934	947	\$5,550	8931	453	\$158
8911	938	\$2,260	10331	448	\$506
8924	938	\$1,330	7994	334	\$455
8899	896	\$2,632	10398	309	\$2,654
8901	891	\$1,285	8009	89	\$1,028

DATA LIMITATIONS ON CYCLE TIME RESULTS

The following points are highlighted regarding the data and results of the cycle time measures from ADOT's databases:

- Cycle time measurements were skewed by unrecorded project work stoppages.

The cycle time measurements only took into account when the work for an overall phase of project delivery began and when it ended. However, on many projects, work stoppages occurred. If the durations of these downtimes were eliminated from the analysis, then the overall cycle times for projects would decrease. However, collection of the information necessary to accomplish this more refined approach would itself require an extensive period.

- Information was collected from three distinct databases.

As previously stated, three databases were utilized for this analysis. During the effort, it was discovered that these databases do not have any direct connection; data in one must be copied, then transferred or manually entered into the others. In some cases, initial expenditure data for the design phase were used due to lack of data for expenditures during the planning phase.

- More than 50 percent of the projects in the sample group were not included in the analysis.

Out of 167 projects let between May 2001 and April 2002, 113 were of the five category types included in the analysis. Of these 113, only 95 projects were included for the initial expenditure/bid date measure; the initial expenditure data field was empty for the remaining 18. Only 40 projects could be included for the date requested/bid date measure due to the lack of information. Projects that were not used included those for which the date requested data field was empty.

- ADOT district offices provided cost estimates, and supplemented project award values and dates on some projects.

Data for the amount awarded for the winning bid was not available for several of the selected projects. In these cases, the PPS database field for the ADOT district-estimated project cost was used. If no cost information was available for a project, the project was eliminated from the analysis.

COMPARISON OF PROJECTS BASED ON ENGINEERING CONSULTANTS

For each of the projects in the sample groups, the primary engineering consultants contracted to perform the work during the scoping and design phases were identified. A comparison among projects that had the same consultant for both scoping and design phases was completed. Overall, the analysis indicates that using the same consultant can reduce cycle time by more than 100 days.

Table 9 below presents the results based on date of project request. Of the 40 projects in the sample pool with valid data for date-of-project request, the consultant data for 11 projects could be determined; all of these were District Minor projects. Of these, five had the same consultant for both phases; the other six had different firms for each phase. The results show that using the same consultant for both scoping and design phases reduced cycle time, on average, by more than 100 days.

Table 9: Effect of Using the Same Engineering Consultant Firm on Project Design, Based on Date of Project Request

Project Category	Same Consultant			Different Consultant			Delta
	No.	Average Duration	Total Value*	No.	Average Duration	Total Value*	
District Minor	5	800	\$2,426	6	907	\$3,532	-107

Source: ADOT, Dye Management Group, Inc. analysis.

Note (*): in millions.

Table 10 below presents the results based on date of initial expenditure. Of the 95 projects in the sample pool with valid data for date of initial expenditure, the consultant data for 27 projects were identified. For Bridge projects, using the same consultant for both phases reduced cycle time, on average, by 515 days. Cycle time for District Minor projects with the same consultant was almost 160 days shorter than for similar projects with different consultants. Due to insufficient data on Major projects and on Pavement Preservation projects, conclusions could not be made.

Table 10: Effect of Using the Same Engineering Consultant Firm on Project Design, Based on Date of Initial Expenditure

Project Category	Same Consultant			Different Consultant			Delta
	No.	Average Duration	Total Value*	No.	Average Duration	Total Value*	
Bridge	3	338	\$720	4	853	\$2,093	-515
District Minor	3	514	\$1,123	9	672	\$4,436	-158
Major	1	2,283	\$12,930	1	1,400	\$4,525	883
Pavement Preservation	1	448	\$506	5	955	\$11,693	-507
Overall	8	661	\$15,279	19	777	\$22,747	-116

Source: ADOT, Dye Management Group, Inc. analysis.

Note (*): in millions.

BENCHMARKING STUDY WITH OTHER STATE DEPARTMENTS OF TRANSPORTATION

The purpose of the benchmarking study was to gain comparative data on project cycle times in other states.

APPROACH

The approach to collecting benchmark data included the following:

- Leveraging the ADOT best project management practices survey.
The best practices survey, performed as part of the ADOT research project (SPR-511), evaluating project management practices, was used to obtain data. Questions were asked regarding cycle time data and measurement. Representatives of the following organizations were interviewed by telephone:
 - Massachusetts Highway Department (MassHighway).
 - Minnesota Department of Transportation (Mn/DOT).
 - Montana Department of Transportation (MDT).
 - Michigan Department of Transportation (MDOT).
 - New Jersey Department of Transportation (NJDOT).
 - New Mexico Department of Transportation (NMDOT).
 - Utah Department of Transportation (UDOT).
 - Washington State Department of Transportation (WSDOT).

Telephone interviews were conducted in order to identify whether these states had assembled cycle time data. Followup calls were made to complete any required data.

- Analyzing data sets from other Dye Management Group, Inc. studies.
Due to the difficulty encountered in deriving cycle time data, we also conducted analysis from data sets that Dye Management Group, Inc. had assembled on preconstruction reviews for other states.

RESULTS

Most of the benchmark states do not maintain and report project cycle time data for projects prior to construction. In a limited number of cases, states have conducted special studies to collect that data. Some of the responding states indicated that they could not allocate time to produce an ad hoc report for our research purposes. A frequent question respondents asked was, “What is the start point?” In a number of states, projects enter and leave the 5-Year Program; therefore, project cycle time is difficult to compute. Despite these limitations, we were able to generate some illustrative comparison data from a few states. Caution should be taken in making comparisons: 1) the definitions of start and end in the data obtained vary between the states, 2) projects are categorized according to different definitions in different states, and 3) the period covered varies between the states. Table 11 presents ADOT cycle time compared to other states.

Table 11: ADOT Cycle Time Compared to Other States (Average Number of Days)

Project Category	Arizona (median number of days)		Montana	Minnesota	
	Scoping to Award	Expenditure to Award	Preconstruction Project Delivery*	Project Duration**	Letting Adjustments***
Major Construction	1,518	1,440	2,555	1,438	827
Restoration/Rehabilitation			1,533		
Reconstruction				1,686	568
Reconditioning				854	247
Resurfacing			1,022	552	46
Pavement Preservation		889			
Road Repair				157	29
Bridge	1,145	393	1,314		
Bridge Replacement				1,854	1,251
Bridge Improvement				469	141
District Minor	974	742			
Safety			949	596	32
Rest Area/Beautification				556	277

Source: ADOT, MDT, Mn/DOT, MDOT, Dye Management Group, Inc. analysis.

Note (*): A study of preconstruction project delivery at MDT was completed in 2000. Analysis conducted as part of the study included evaluating the average duration between the preliminary field review and bid ready date for several types of projects. Data were collected and analyzed for projects delivered in the period from 1997 through 2000.

Note (**): Project Duration refers to the period from the end of the first project activity to the construction letting. Data refer to projects from January 1, 1997, through December 31, 2001.

Note (***): Letting Adjustments refer to the difference in elapsed time between the date a project was originally programmed for letting and when it was actually let. Data refer to projects from January 1, 1997, through December 31, 2001.

Minnesota Department of Transportation

Table 12 and Table 13 summarize data on project duration and letting adjustment for Minnesota. For our purposes, *project duration* refers to the period from the end of the first project activity to the construction letting. *Letting date adjustment* refers to the difference in elapsed time between the date a project was originally programmed for letting and when it was actually let.

Table 12: Project Duration, 1997–2001

Project Category	Total Projects	Average Duration (days)	Standard Deviation*	Average Duration (Years)
Major Construction	137	1,438	748.07	3.94
Reconstruction	70	1,686	621.57	4.62
Reconditioning	121	854	487.61	2.34
Resurfacing	279	552	296.56	1.51
Road Repair	211	157	133.91	0.43
Bridge Replacement	99	1,854	925.26	5.08
Bridge Improvement	96	469	313.72	1.28
Safety	121	596	377.14	1.63
Rest Area/Beautification	51	556	390.60	1.52
Total	1,185			
Average Days		791		
Average Years				2.16

Source: Mn/DOT, Dye Management Group, Inc. analysis.

Note (*): For example, if the average duration is 1,000 days and the standard deviation is 200, we would have reasonable confidence that the project durations would fall between 800 and 1,200 days.

Table 13: Letting Date Adjustment, 1997–2001

Project Category	Total Projects	Average Duration (days)	Standard Deviation*	Average Duration (Years)
Major Construction	137	827	570.00	2.27
Reconstruction	70	568	391.13	1.56
Reconditioning	121	247	338.65	0.68
Resurfacing	279	46	232.33	0.13
Road Repair	211	29	144.22	0.08
Bridge Replacement	99	1251	841.26	3.43
Bridge Improvement	96	141	269.26	0.38
Safety	121	32	492.07	0.09
Rest Area/Beautification	51	277	250.23	0.76
Total	1,185			
Average Days		324		
Average Years				0.89

Source: Mn/DOT, Dye Management Group, Inc. analysis.

Note (*): For example, if the average duration is 1,000 days and the standard deviation is 200, we would have reasonable confidence that the project durations would fall between 800 and 1,200 days.

Montana Department of Transportation

A study of preconstruction project delivery at the MDT was completed in 2000. Analysis conducted as part of the study included evaluating the average duration between the preliminary field review and the bid ready date for several types of projects. Data (as shown in Table 14) was collected and analyzed for projects delivered in the period from 1997 through 2000. This is a point after the project is in the 5-Year Program and most likely a little later in the project life cycle than the *expenditure to award* measure used in our analysis of ADOT project cycle time.

Table 14: Project Duration by Type of Project

Project Category	Duration (years)	Duration* (days)
New Construction/ Rehabilitation	7.0	2,555
Restoration/Rehabilitation	4.2	1,533
Resurfacing/Minor Widening	2.8	1,022
Bridge	3.6	1,314
Safety/Traffic	2.6	949
Overall	4.0	1,460

Note (): Calculated from cycle time duration in years.*

Michigan Department of Transportation

Michigan is one of only a few states surveyed that has monitored and kept track of cycle time. Table 15 presents project cycle durations, between the scoping date and the project letting date, for projects let between 1998 and 2001.

Table 15: Project Duration and Value by Type of Project

Project Category	Projects	Duration (days)	Average Value
Bridge	62	449	\$2,522,000
Major	66	595	\$8,224,000
Minor	115	397	\$862,000
Pavement Preservation	15	427	\$7,568,000

New Jersey Department of Transportation

NJDOT, in conjunction with the American Association of State Highway and Transportation Officials (AASHTO), recently completed a major survey of state departments of transportation and their management of cycle time. Results are still pending, with a report to AASHTO due in January or February.

The work in progress was discussed with the researchers. A key finding from their work, which was confirmed by ADOT's best practices survey, is that the majority of state departments of transportation do not keep track of project cycle time. Projects are managed; however, a variety of issues create delays. Projects are re-baselined, a process

in which the original schedule is shifted out to compensate for the delay. Under this procedure, project start dates are not maintained, so determining the actual cycle times is impossible.

For New Jersey, project cycle times can be described in terms of the relative complexity of a project, including requirements for environmental impact statements or major utility realignment work. The data in Table 16 indicate the average design cycle times for projects let by NJDOT. These data are not directly comparable to our ADOT data.

Table 16: Project Duration by Type of Project

Type of Project	Duration (years)	Duration* (days)
Requiring an EIS	6.0	1,460
Requiring an EA	5.5	2,008
Complex (Significant Right-of-Way)	4.5	1,643
Complex (Significant Utility Relocation)	4.0	1,460
Simple Project	2.0	730

Note (): Calculated from cycle time duration in years.*

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Following are the conclusions based on the results of the cycle time analysis:

- **There is some indication that ADOT's more complex projects are not taking longer than projects in other states; however, pavement preservation is taking longer.**

Although there are limitations in the state-to-state data used for comparisons, the results reported indicate that more complex ADOT projects, major construction projects, and bridge projects are not generally taking longer than similar projects in other states. In contrast, pavement preservation projects appear to be taking longer.

- **Rework is a major factor in delay.**

Interview results indicate that rework increases cycle time and is caused by:

- Poor communication among the parties involved in the pre-design and design processes.
- Lack of district involvement until later stages of design.
- Limited control mechanism to "lock in" scope and design at an early stage.
- Changes due to the permitting process.
- Quality control process not focused on early stages of the design process.
- Quality problems caused by schedule requirements.

- **Environmental and right-of-way activities could start earlier.**

Although this study did not conduct a business process analysis, technical staff indicated that due to frequent project changes, especially with regard to scope, they are reluctant to begin right-of-way work until scope issues are resolved. Best practices analysis results indicate that, in general, states have worked on conducting environmental and right-of-way activities earlier in the process and in parallel with other design activities. Interviews indicate:

- Environmental and right-of-way needs should be identified and tasks should be performed earlier in the process.
- Right-of-way staff are reluctant to do tasks earlier due to the experience of frequent changes.
- **There is not enough standardization of project management procedures, approaches, and designs.**

The best project management practices study indicates that:

- There is no automation on repetitive projects.
- ADOT is not using standardized templates for designs.
- Not all project managers use the established process.
- Project managers/teams establish their own schedules and timelines for the project.

This indicates that there is no basis or standard for acceptable cycle time from which to manage project delivery. The following observations are drawn from review of documentation and interviews:

- ADOT does not establish or manage project delivery based upon work standards for activity duration by category of project.
- There is limited documentation of how long work “should take.”
- Management information on cycle time is limited.
- Management objectives and performance expectations are focused on letting schedule accomplishments, not delivery time or cycle time.

- **There is a lag between pre-design and design**

The time between identification of a project need and the beginning of design work adds to cycle time. The factors driving this include the following:

- Due to funding, prioritization, and other factors, there is a lag between pre-design and inclusion of scoped projects in the program.
- When programmed, the conditions (environmental, real estate, traffic) may have changed, requiring reexamination of the scope.
- Current funding constraints and underestimation of program costs slow down delivery.
- Cycle time for District Minor projects may be longer due to additional activities such as permitting.

RECOMMENDATIONS

The recommendations outlined below are based on the research performed as part of the cycle time analysis and on information developed for the best project management practices study.

Management Information and Accountability

The following recommendations address the paucity of management information and organizational accountability for cycle time. They identify immediate actions that can be readily instituted.

Recommendations addressing the broader need for improved management information for program and project management purposes are not made here. They will be made in the best project management practices report. In brief, the recommendations here address the need for monitoring duration by major activity and by the start and finish dates. This type of information will provide data from which to systematically reduce cycle time.

Following are the management information and accountability recommendations:

- **Monitor and report project cycle time.**

This requires establishing agreed measures of cycle time. Issues to be resolved include determining a starting point; the end point could be set at the time the project is “ready” to be advertised. It will be important to account for situations in which projects enter the 5-Year Program, are not designed, and then reenter later.

With a history of cycle time data, it will be possible to identify trends and opportunities for improvement.

- **Establish project duration standards by project type.**

The intent is to establish some work standards for project duration. These would need to be established by project type and by category of activity. While there is variation across projects and there are arguments that can be made about the difficulty of doing this, best practice analysis shows that other states start their cycle time management from such data.

Delays Between the Planning, Pre-Design, STIP, and Design Processes

ADOT is confronted with a number of process and organizational issues that impact the flow of a project from planning, through pre-design, into the 5-Year Program, and then through the design process. The issues are broader than cycle time. They include ensuring that the problem or need identified and addressed in planning is met through the pre-design and design process. Each time a scope is revisited, delay and rework adversely impact cycle time.

A specific cycle time delay is the apparent lag between scoping or pre-design and when work starts on the project. The impact of this disconnect on ADOT is large. It also impacts ADOT's relationship with its customers and partners because the time from pre-design to project completion is long. In addition, not all projects that go through the pre-design process are included in the 5-Year Program in the year that the pre-design work is done. The recommendation is to make solving this problem as priority.

Following is the recommendation for managing the delays between the planning, pre-design, Statewide Transportation Improvement Plan (STIP), and design processes:

- **Address the disparity between the scoping process and design.**

Addressing the disparity between planning activities, pre-design, and design offers a large opportunity for reducing cycle time. This study has not undertaken a detailed process evaluation. Therefore, the recommendation identifies options that will enable ADOT to address this issue. These options are listed below:

- Option 1. Make project managers responsible for scoping using the pre-design group expertise as a technical resource.

Under this action, project managers would have responsibility for scoping. Implementation will need to address whether this should include any scoping prior to inclusion in the 5-Year Program or whether there should be a more detailed project scope definition once the project is in the program.

- Option 2. Reengineer the pre-design and scoping processes.

This option could be performed in conjunction with other options. Under this option, the current process would be reengineered. Ideas to consider would be establishing a new project nomination or initial scoping process (prior to the 5-Year Program). The objective would be to reduce delay between scoping and design start.

Strengthened Project Management

Implementation of the recommendations from the best project management practices study will position ADOT to reduce cycle time. These recommendations are designed to improve ADOT's overall management and delivery of projects from initiation through to advertising. The recommendations address the policy, procedural, and organizational changes necessary to improve project schedule management. With these recommendations in place, ADOT will:

- Know how long projects should take and how long the duration of major activities should be.
- Establish a duration (project cycle time) at the outset, and manage delivery to that duration.
- Establish controls of scope and budget that will reduce adverse impacts on schedule management. For example, if the project scope is locked in beyond a certain point, then the amount of rework that causes schedule slippage would be limited.
- Have greater project delivery standardization.
- Be able to have a baseline from which to identify cycle time reduction opportunities.

Following is the recommendation for strengthened project management:

- **Establish a cycle time baseline and an agenda for action to reduce cycle time.**

The recommendation is to establish a project cycle time baseline and, on an ongoing basis, to identify opportunities for ensuring predictability of cycle time and reducing project cycle time. These will include:

- Process improvements.
- The use of technology such as standard design templates to aid designers.
- The use of alternative contracting approaches such as incentives or disincentives designed to reduce construction cycle time.
- The use of multi-project resource loading analysis to identify and manage bottlenecks that are caused by uneven workflow for specialized units.
- Other initiatives.

Analysis and Action to Address Process Bottlenecks

Bottlenecks in the process arise because work planning by technical managers is difficult due to weak scope management and limitations in the management information available. In addition, ADOT does not balance work load across projects. With more disciplined project management, especially scope management, ADOT will be able to identify and address process bottlenecks.

Following is the recommendation for reducing process bottlenecks:

- **Identify and address bottlenecks.**

While our analysis did not quantify the impacts, the interview results and conclusions drawn from assessment of ADOT's current practices indicate that there are likely a number of bottlenecks in the process that cause delay. These include local government agreements, approval of consultant work scopes, and the final plan checking process.

The recommendation can be implemented by convening work groups to identify and address bottlenecks and their magnitude, and to assess the actions that can be taken to reduce them.