

Promoting the Use of Advanced Work Packaging

Phase 1



Final Report DCC-04

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Promoting the Use of Advanced Work Packaging (AWP)

Phase 1

*Research Team DCC-04, Promoting the Use of Advanced Work Packaging
Construction Industry Institute*

Final Report DCC-04

March 2020

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The University of Texas at Austin

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Executive Summary

The Construction Industry Institute (CII) challenged Research Team DCC-04 (RT-DCC-04) to recommend strategies for promoting the use of Advanced Work Packaging. AWP is a CII Best Practice that promotes a disciplined process for project planning and execution. It aims to systematically align the engineering, procurement, and construction disciplines across the project life cycle.

In order to achieve its goal, the team conducted a survey and a series of interviews to accomplish the following tasks:

1. Identify companies that are implementing AWP.
2. Analyze the main barriers these companies face during AWP implementation.
3. Recommend potential solutions to overcome these barriers.
4. Find out why some companies choose not to implement AWP.
5. Uncover opportunity areas where additional research could positively affect the use of AWP at the industry level.

The research team developed an online survey to gain a better understanding of the current status of AWP implementation. This survey obtained 68 responses from 36 companies. It collected data about these companies' AWP implementation journeys, including project focus, implementation maturity level, barriers to implementation, potential solutions to overcoming these barriers, and recommendations on how to promote the use of AWP. Along with the survey, the team conducted 11 interviews to gather more data on implementation challenges and critical success factors.

RT-DCC-04's research findings indicate that AWP is being utilized globally by projects in a wide range of sizes. Among the companies that participated in this study, the average AWP implementation maturity level (based on the five maturity model dimensions set out by RT-272) was 1.8 on a scale that ranges from 1.0 to 3.0, with 3.0 being the most mature (CII/COAA 2013a). RT-DCC-04's analysis also showed that there was greater maturity in aspects related to understanding AWP benefits, while maturity was lower in dimensions that dealt with AWP implementation strategy, training, and support.

RT-DCC-04 also conducted a comprehensive analysis of AWP implementation barriers. One of the findings indicated a relationship between the barriers a company faced and its maturity level:

- **Companies with higher maturity levels** faced barriers related to integrating AWP with engineering and integrating AWP procedures with existing processes.
- **Companies with median maturity** reported encountering barriers related to a lack of mature resources to implement AWP and an insufficient understanding of how to integrate AWP with existing procedures.
- **Companies with lower maturity** presented barriers related to recognizing the value of AWP and understanding its concepts.

The team identified potential solutions to the main AWP implementation barriers and also compiled its suggestions on how to promote the use of AWP. The research findings made clear that there are ways to positively promote AWP implementation at the industry level. The team isolated two topics that need more attention now:

1. Improving the integration of engineering and AWP implementation
2. Providing easier access to AWP case studies and implementation resources

A second phase of this research will focus on these areas that were identified by the team's first phase.

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Chapter 1

Introduction

Advanced Work Packaging (AWP) is a CII Best Practice that promotes a disciplined process for project planning and execution. It aims to systematically align the engineering, procurement, and construction disciplines across the project life cycle. The AWP methodology shifts the planning focus to the early stages and is based on three main components:

1. Construction work packages (CWPs)
2. Engineering work packages (EWPs)
3. Installation work packages (IWPs)

The logical and iterative breakdown of a project into these three deliverables provides a framework for effective and consistent planning throughout project duration.

AWP has the potential to improve the project delivery process. Early evidence from CII's Research Team 272 (RT-272) indicated the following benefits of AWP implementation, compared to traditional planning and execution processes (CII/COAA 2013a):

- Up to 25% increase in construction productivity
- Up to 10% decreases in total installed cost (TIC), with increased savings for owners and increased profitability for contractors
- Improved schedule performance, with projects delivered on schedule
- Improved safety performance, with zero lost time accident records
- Increased quality, with reduced construction rework
- Increased predictability, in terms of cost and schedule estimates

RT-319 validated the benefits of implementing AWP. It used qualitative and quantitative research methods that supported the case for AWP as a best practice for the industrial construction sector (CII 2015). Even though AWP became a CII Best Practice in 2015, its use has remained limited among companies in the downstream and chemicals sector. Hence, this work seeks ways to promote AWP use in this sector.

Research Objectives

RT-DCC-04's main goal was to promote AWP use in the downstream and chemical sectors. To that end, the team established the following objectives:

- Identify which Downstream and Chemicals Sector Committee (DCC) member organizations are implementing AWP.
- Identify the barriers that DCC member organizations face during their implementation of AWP.
- Pinpoint the strategies that DCC member organizations are adopting to overcome these barriers to successful implementation of AWP.
- Discover why some DCC member organizations choose not to implement AWP.
- Uncover opportunities related to “people,” “process,” and “technology” aspects that can be leveraged to improve the utilization of AWP.

Chapter 2

Research Methodology

Overview

This chapter presents the methodology RT-DCC-04 followed to achieve its research objectives. The team's approach is illustrated in Figure 1.

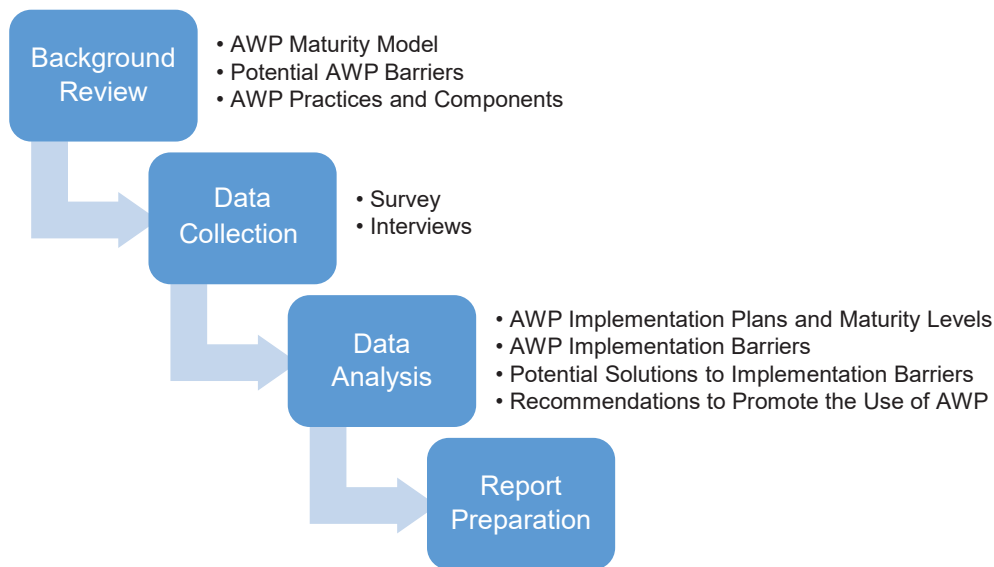


Figure 1. Research Methodology

Background Review

RT-DCC-04 conducted a background review to gather relevant findings from previous studies. The team aimed to incorporate knowledge from related AWP studies and to align with existing AWP implementation efforts. The team's search leveraged resources and/or findings from the following organizations:

- CII's Downstream and Chemicals Sector Committee (DCC)
- CII's Advanced Work Packaging Community for Business Advancement (AWP CBA)
- CII's Technology Committee
- Construction Owners Association of Alberta (COAA)
- Organizations that support the implementation of AWP (e.g., Construct-X, Autodesk, ExxonMobil, Eastman, Bechtel, Worley, Group ASI)
- Universities that are conducting AWP-related research (e.g., University of Alberta and The University of Texas at Austin)

Data Collection

The team's approach to data collection involved a survey and interviews with subject matter experts.

Survey

The team conducted a survey by issuing it through CII to all members of the DCC. The survey was a self-assessment tool that an average participant took an estimated 20 minutes to complete. Created by using Qualtrics software, this survey addressed topics that were relevant to achieving RT-DCC-04's research objectives.

The survey was composed of four primary blocks of questions. Each block had a different focus and gained a different perspective on the AWP program at the respondent's company. (The complete survey questions are presented in Appendix A.)

1. Company and respondent information

This block gathered information on the respondent and the company, including the respondent's job position and experience. This section asked whether the company was implementing AWP, and upon which types of projects the company used or planned to use AWP. If the respondent marked that the company was not implementing AWP, the survey skipped to a question asking why this was so. If he or she indicated that the company had implemented AWP, the survey would instead advance to questions regarding the maturity level.

2. Maturity level

This section assessed the responding company's maturity in AWP implementation. Its questions were based on the maturity model matrix presented by RT-272 (CII/COAA 2013a). It assessed the company's AWP maturity in terms of the following five dimensions:

- View of AWP
- AWP implementation strategy
- Work processes and deliverables
- Culture and performance metrics
- Training and support

For each dimension, the survey asked the respondent to rate the company's maturity by assigning it to one of five levels (offering half-step levels to increase the flexibility of possible responses):

- Level 1** – The maturity of the organization is low.
- Level 1.5** – The maturity of the organization is between Level 1 (above) and Level 2 (below).
- Level 2** – The maturity of the organization is median.
- Level 2.5** – The maturity of the organization is between Level 2 (above) and Level 3 (below).
- Level 3** – The maturity of the organization is high.

3. Barriers and potential solutions

This section of the survey identified which barriers the company was facing and how these barriers affected AWP implementation. Its first question was open-ended. It asked the respondent to list the company's main barriers to implementing AWP and to comment on how they kept the company from using AWP. In this way, the survey could capture whichever barriers a respondent thought of first, before any of the subsequent questions could guide or bias the answers.

Next, this section presented multiple-choice questions. The survey offered a list of barriers (shown in Table 1 on the following page) and asked the respondent to assign a level of severity to each barrier:

- Major
- Moderate
- Minor
- None
- Not Applicable

If the respondent marked "major" beside a given barrier, the questionnaire would provide a box where the respondent could write which potential solution the company had used to overcome that specific barrier. To avoid survey fatigue, respondents were only asked to supply these additional details for major barriers. (The number in front of each barrier in Table 1 is a reference number; in no way does it rank the barrier.)

After this section, the survey offered two questions to support the other CII research teams contemporaneously working on AWP topics, Research Teams 364 and 365. These questions addressed barriers related to the integration of AWP with procurement and supply chain management, and to its integration with commissioning and startup.

Table 1. AWP Implementation Barriers

1. Lack of buy-in	28. Inconsistency in AWP implementation due to lack of structured process	53. Transition from construction by area to commissioning by system
2. Lack of AWP champion/leadership	29. Need (or perceived need) for additional project team members for AWP	54. AWP program is not owner-driven
3. Lack of clear understanding of AWP methodology and processes	30. "Silos" among project team groups limit integration	55. Lack of financial incentives to improve execution efficiency
4. Expectation of limited (or no) benefits to company from AWP	31. Too many unknowns to effectively sequence IWPs well in advance	56a. Internal push-back from upper management
5. Cost to implement	32. Difficulty in scoping/sizing IWPs	56b. Internal push-back from middle management
6. Company not interested in implementing AWP	33. Maintaining a constraint-free backlog of IWPs throughout the project	56c. Internal push-back from project managers
7. Awaiting more industry AWP project results before implementing	34. Difficulty with ongoing tracking/closing of IWPs	56d. Internal push-back from information management/technology
8. Previous attempt to implement AWP was considered unsuccessful	35. Belief that experienced field leadership and crews can construct without IWPs	56e. Internal push-back from design engineering management
9. Lack of ongoing alignment among owner, contractors, suppliers, and others	36. Current company processes would have to be revised to include AWP	56f. Internal push-back from design engineers
10. Lack of alignment between AWP implementation strategy and field execution	37. Changes to roles of individuals when implementing AWP	56g. Internal push-back from procurement
11. Lack of alignment between AWP and front end planning	38. Difficulty in making AWP fit-for-purpose on various sizes of projects	56h. Internal push-back from project controls
12. Contractor does not buy in early enough	39. Design engineering organization not supportive of AWP	56i. Internal push-back from construction managers
13. Lack of alignment between AWP implementation strategy and contract type	40. Lack of inter-organizational coordination following a scope change	56j. Internal push-back from superintendents
14. Owner does not include clear AWP requirements in the contract	41. Project controls not aligned with AWP	56k. Internal push-back from general foremen
15. Contract size does not support AWP implementation	42. Materials management/logistics issues (materials to the work face)	56l. Internal push-back from foremen
16. Lack of alignment between AWP implementation strategy and field strategy	43. Lack of efficient/on-time scaffolding management	56m. Internal push-back from field crews
17. Lack of alignment between AWP implementation strategy and project scope	44. Current company culture does not fully support AWP	56n. Internal push-back from schedulers
18. Not enough qualified resources for implementing AWP	45. Misperception that company already performs AWP (no change needed)	56o. Internal push-back from cost estimators
19. Owner engages contractors too late to effectively implement AWP	46. Do not need AWP because current project performance/results are good enough	57a. External push-back from owner
20. Owner late in furnishing items or information	47. Weaknesses in overall AWP organization/coordination	57b. External push-back from engineering design contractor
21. Progress payments not linked to AWP deliverables	48. Lack of training	57c. External push-back from engineering design/procurement contractor
22. Construction company not available to provide timely path of construction input	49. Low level of AWP maturity among contractors	57d. External push-back from engineering design/procurement/construction contractor
23. Too many unknowns to effectively sequence CWP's well in advance	50. Poor integration of AWP information system with other corporate systems	57e. External push-back from construction management contractor
24. Turnover/startup personnel not available to provide timely path of construction input	51. Lack of attributes in the design model	57f. External push-back from construction contractor
25. Procurement personnel not available to provide timely path of construction input	52. Manual or paper-based IWP management system is inefficient for the project size	57g. External push-back from subcontractor
26. Engineering design sequence not able to match construction sequence		57h. External push-back from suppliers
27. Late AWP implementation		

4. Recommendations and opportunities for improvement

This last block of the survey pinpointed which potential solutions the company was taking or planning to take to overcome the reported barriers. It invited the respondent to provide recommendations on how to promote the use of AWP across the industry and to uncover areas that offered opportunities for improvement. This block also asked whether the respondent would be willing to participate in a follow-up interview. When the answer was “yes” or “maybe,” the team would include that person as a potential candidate to be interviewed during the next phase of the research.

The survey was distributed through an anonymous link via Qualtrics, sent by email to CII member companies. Research team members, CII staff, and DCC members helped disseminate the link and ensured that companies were participating in the survey. The survey was not directed to any specific group of respondents (i.e., it was not intended only to reach only individuals representing engineering or construction). Any qualified representative in a company could respond, and each company could complete more than one survey. The team felt that this approach could show different perspectives of AWP implementation. In cases where a company submitted more than one response, the separate implementation maturity results were averaged.

The survey received 68 responses from 36 different companies. These responses were categorized according to company role on projects (i.e., owner, contractor, service provider, non-CII member) (see Figure 2).

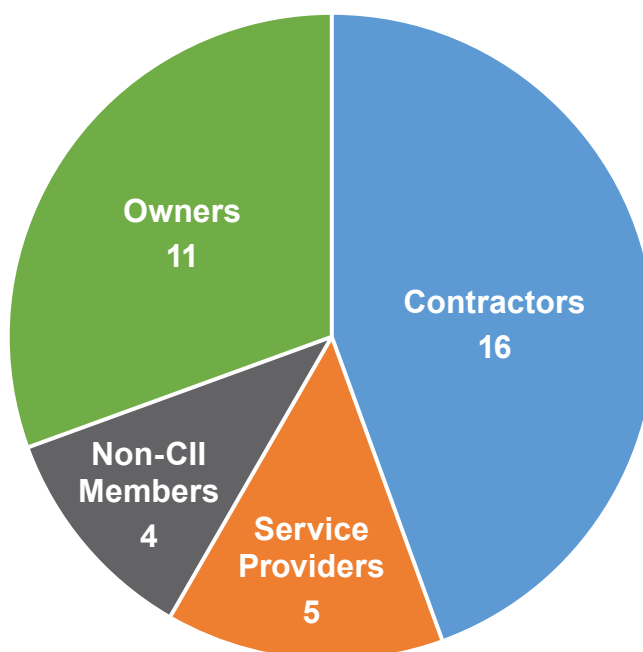


Figure 2. Respondents' Companies Categorized by Role on Projects (n=36)

Appendix B lists the companies that participated in the survey. The survey captured whether a respondent was from the home office (13 respondents) or a field office (54 respondents). Additionally, the survey gathered information about each respondent's extent of industry experience and AWP experience (see Figure 3).

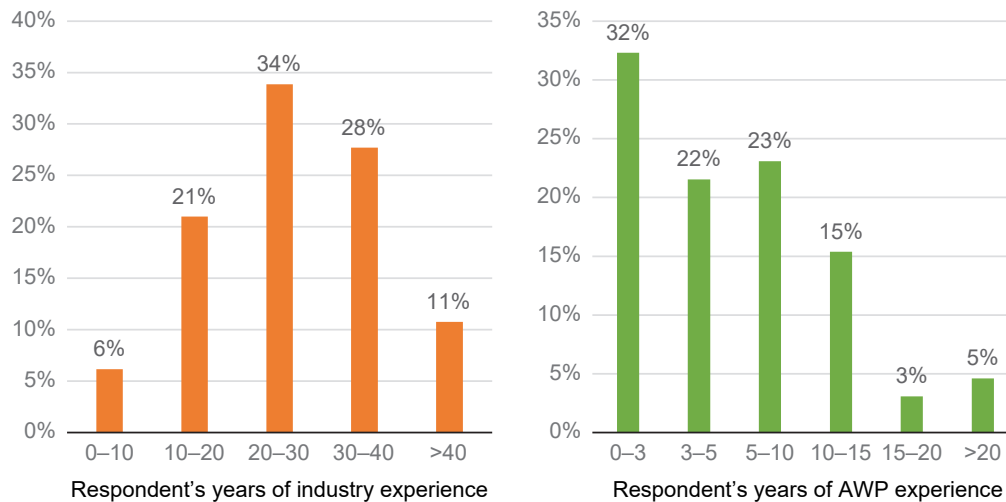


Figure 3. Respondents' Years of Experience

Interviews

As a way to expand on the survey results, the researchers also carried out semi-structured interviews that provided opportunities to better understand a company's AWP procedures and efforts and, thereby, to clarify any questions that may have arisen from the survey responses. Along with each interview invitation, the team sent a document that contained the interview guidelines. Each semi-structured interview lasted 30 minutes and was conducted by members of RT-DCC-04. The team selected which participants to interview by considering their survey responses and interview availability.

The interview was designed to most efficiently elucidate relevant information introduced in the survey. Each interview was divided into the following four sections:

1. An overview of the company's AWP implementation efforts to date – This first part of the interview focused on the company's efforts to implement AWP. It was important to grasp where the company stood in the AWP implementation journey. The main point addressed in this section was the company's maturity level, which allowed each interviewee to comment on and clarify the organization's existing process regarding AWP.

2. Top barriers that the company faced during its implementation efforts – The second section dealt with which barriers the company was facing. Each interviewee listed the main barriers and commented on them from a personal point of view. This section focused on understanding the details of each barrier and how it affected the AWP process.
3. Detailed potential solutions that the company is implementing (or plans to implement) to overcome these barriers – The next section concerned potential solutions the company had taken (or contemplated taking) to overcome the main barriers in the previous section, and discovering how the company used AWP to best fit its needs. This section allowed the researchers to gain a better understanding of each company's solution to implement AWP more successfully. It also gave RT-DCC-04 a better understanding of the barriers that still needed solutions.
4. Industry-level recommendations, information, or actions to further promote the use of AWP and areas of opportunity – This final section of the interview was intended to collect participants' recommendations for what CII could do to promote AWP at the industry level and to uncover opportunity areas that could be improved. The answers from this section showed the team that it would need to continue this research effort into a second phase.

By conducting these interviews, team members expected to understand the industry's needs and what could be done to help companies implement AWP more successfully.

The team conducted 11 interviews with experts from 10 different companies:

- | | |
|-----------------------|--------------------|
| • Bechtel | • ExxonMobil |
| • Black & Veatch | • Hargrove |
| • Burns and McDonnell | • Kiewit |
| • Dow | • LyondellBasell |
| • Eastman | • Southern Company |

Appendix K summarizes these interviews without naming each company.

The interview findings gave the researchers a deeper understanding of the respondents' AWP implementation efforts. The participants explained some of the barriers that they had listed as "major" in the survey and detailed how they decided to give a barrier that designation. This process helped the team to recognize the improvement opportunity areas and to define how CII could proceed to help promote AWP at the industry level, making sure to cover the expressed needs of the companies.

Data Analysis

The team's data analysis fell into two segments:

1. The quantitative analysis was crucial to identify and rank each barrier, and to define potential solutions to the barriers.
2. The qualitative analysis validated the quantitative analysis and also provided more details with regard to the findings.

Report Preparation

RT-DCC-04 prepared a report based on its research findings and recommendations. The report accomplished several objectives:

- It characterized the status of AWP implementation across DCC members.
- It identified barriers to the successful implementation of AWP.
- It uncovered strategies for overcoming these barriers.
- It made recommendations on how to promote the use of AWP.

Scope Limitations

The data obtained through the survey and interviews were based on the respondents' experiences with and perspectives on AWP implementation. RT-DCC-04 assumed that the data collected from the survey and interviews were representative of most members of DCC. However, because the research captured viewpoints from a relatively small number of companies ($n = 36$), the team cautions that the results may not be representative of the whole industry.

Chapter 3

Background Review Findings

RT-DCC-04's background review facilitated its development of the subsequent research steps. The review focused on three relevant topics: the AWP maturity model, potential AWP carriers, and AWP practices and components.

AWP Maturity Model

Research Team 272 developed an AWP maturity model, which it detailed in Volume II of CII Implementation Resource 272-2, *Advanced Work Packaging: Implementation Guidance* (CII/COAA 2013a). A company or project can use this AWP maturity model to assess its current state of AWP implementation. The maturity model is divided into five dimensions and three levels of implementation maturity, as Figure 4 shows.

Advanced Work Packaging Implementation Maturity Model			
	Level 1: AWP Early Stages	Level 2: AWP Effectiveness	Level 3: AWP Business Transformation
View of AWP	The potential of the implementation of AWP strategy is not understood and has few champions. AWP is not a priority within the corporate vision.	AWP is seen as part of the business solution - being both an opportunity and a challenge.	AWP is fully integrated with the business strategy and is seen as invaluable. It enables true differentiation between you and the competition.
Project AWP Strategy	AWP is developed on an ad hoc basis - most often driven by customer demands.	Integration of AWP strategies are routinely developed and updated. These often seek to overcome integration and communication issues across project organizational units (silos). AWP is now included in all contracts.	Barriers to implementation of AWP strategies are minimal and project-specific planning focuses more on advancing strategic business needs and interests. Contracts include AWP language and supported by commercial terms, plans and procedures.
Work Processes & Deliverables	Work process and deliverables are in development stage. They are not well defined and are not structured for implementation across business units (silos). Inputs and outputs required of stakeholders to support the strategy are not defined and no discipline involved. Most processes support individuals or isolated work groups and not fully integrated.	Work processes and deliverables for individual business functions or departments are mostly well defined and standardized. Integration of these processes are still problematic across functional unit lines. Frustration will be experienced when some functions are progressing towards AWP implementation but are set back by other silos who are not supporting the integration.	Work processes and deliverables are fully integrated across functional units. Each stakeholder understands their responsibilities to provide accurate and timely deliverables to support the strategy. This allows more time for productive analysis of deliverables and supports flexible, adaptable integrated work processes. Work processes represent best-in-class use of corporate knowledge and AWP practices.
Organization Culture & Performance Metrics	Most work occurs inside functional units with minimal collaboration or integration. "Over the wall" approaches are common. The culture embraces silos. Performance metrics are silo-oriented. For example engineering performance is based on percentage of hours "burned" vs. budget and not focused on the deliverables (EWP's) delivered to meet the Path of Construction.	Functional responsibilities for AWP are clearly defined and integration is occurring across key functional lines. Many silos have been bridged, but some still exist. Overcoming these is viewed as an opportunity for advancement. Integrated approaches are valued. Performance metrics are a mix of silo and team oriented basis. For example status is based on percentage of complete EWP's and IWP's that have been delivered on or before required to support the Path of Construction.	Silos are no longer a barrier to implementation of AWP and the organization has seamless boundaries between work functions and major project stakeholders. Silos that do exist remain for business, not technical reasons. Integrated approaches and associated benefits are ingrained in the culture. Performance metrics focus on business performance, customer satisfaction and team success. Continuous improvement processes in place.
Training & Support	Some training standards are in place based on job descriptions to support AWP. Team members may take the training but are still not supported within their organization to implement what they have learned.	Training to fully support a successful AWP implementation is fully available, valued and supported within the organization.	Training is continuous and the organization is considered an industry leader.

Figure 4. Maturity Model Matrix by RT-272 (CII/COAA 2013a)

After RT-272 completed its work, CII commissioned RT-319 to validate AWP as a best practice. RT-319 developed its own AWP maturity model and applied it to rate a set of industrial projects. Although RT-319's maturity model assessment was inspired by the RT-272 model discussed above, RT-319's maturity dimensions and maturity levels were different. The maturity levels were calculated by measuring the diligence of AWP adoption according to three maturity dimensions:

1. Adherence to prescribed procedures
2. Alignment between execution plans and associated discipline-specific work packaging deliverables
3. Inclusion of AWP guidelines into key participants' contracts

To assess maturity, the RT-319 researchers used the following six indicators – two for each maturity dimension – and calculated the AWP maturity level as the geometric average of these six indicators' scores (O'Brien and Ponticelli 2016).

Process Adherence

- In the early planning stage, project execution planning documents included construction sequences, phases, and boundaries to support AWP.
- Major equipment and procurement data were identified and integrated with work-packaging schedule.

Organization Alignment

- The work-packaging process was aligned with project procedures.
- The work breakdown structure was aligned with the AWP execution plan and associated work packages (e.g., CWP, EWP, IWP).

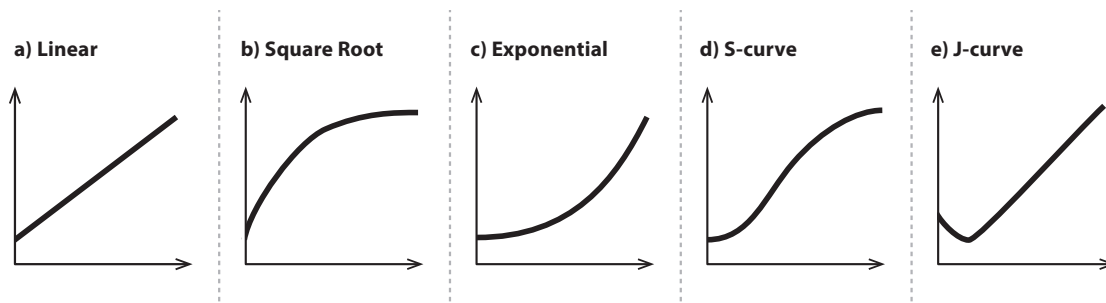
Contract Integration

- Roles and responsibilities were defined in accordance with AWP guidelines.
- Work-packaging requirements and deliverables were integrated within key project participants' contracts.

RT-319 calculated project performance by measuring the gap between estimated and actual project performance. Table 2 shows the matrix the team proposed to measure project performance (O'Brien and Ponticelli 2016). By graphing the potential scenarios for interactions between the maturity level and project performance, RT-319 revealed that projects followed five patterns (e.g., linear, square root, exponential, S-curve, and J-curve), as shown in Figure 5 (O'Brien and Ponticelli 2016). A qualitative analysis of the findings from Research Teams 272 and RT-319 enabled RT-DCC-04 to classify any company based upon the maturity model created by RT-272.

Table 2. Indicators and Scales for Project Performance (O'Brien and Ponticelli 2016)

Performance dimension	Score				
	(1)	(2)	(3)	(4)	(5)
Productivity	In line or worse than estimates (or previous similar projects)	Improvements between 0% and 10%	Improvements between 10% and 20%	Improvements between 20% and 30%	Improvements higher than 30%
Cost	The project was delivered with cost overrun	The project finished within the planned budget including approved scope changes	The project finished under planned budget (between 0% and 5% TIC)	The project finished under planned budget (between 5% and 10% TIC)	The project finished under planned budget (more than 10% TIC)
Safety	TRIR in line or worse than company average	TRIR was slightly less than previous similar projects or company's average (between 0% and 10% reduction)	TRIR was less than previous similar projects or company's average (between 10% and 20% reduction)	TRIR was greatly less than previous similar projects or company's average (more than 20% reduction)	TRIR was 0
Schedule	The project was delivered with major schedule delay	The project was delivered with minor delay	The project finished within the planned schedule	The project was delivered with minor advance of time	The project was delivered with major advance of time
Quality	Percentage of issued IWPs that have an RFI resulting in a construction change order is higher than 80%	Percentage of issued IWPs that have an RFI resulting in a construction change order is between 60% and 80%	Percentage of issued IWPs that have an RFI resulting in a construction change order is between 40% and 60%	Percentage of issued IWPs that have an RFI resulting in a construction change order is between 20% and 40%	Percentage of issued IWPs that have an RFI resulting in a construction change order is lower than 20%
Predictability	Major continuous changes to IWP estimates	Major sporadic changes to IWP estimates	Small continuous changes to IWP estimates	Small sporadic changes to IWP estimates	IWP estimates were consistently met, reflecting project execution

**Figure 5.** Patterns between AWP Maturity and Project Performance (O'Brien and Ponticelli 2016)

AWP Implementation Barriers

RT-DCC-04 conducted a background review of potential AWP barriers. It began by considering barriers identified by RT-272, presented by RT-272 researchers at the 2012 COAA Best Practice Conference, and refined by RT-319. RT-DCC-04 then added more inputs of its own. The final results (captured in Table 1 on page 6 of this document) represent a combination of barriers identified across all of these efforts. The number in front of each barrier is a reference number; in no way does it rank the barrier.

Barriers Identified by RT-272

RT-272 conducted interviews with subject matter experts to identify perceived challenges for AWP implementation. The most common difficulties identified during the interviews related to lack of alignment, change inertia, lack of buy-in, lack of experience and training, and lack of inter-organizational coordination.

Barriers Presented at the 2012 COAA Best Practices Conference in Edmonton, Canada

During the 2012 COAA Best Practices Conference, RT-272 researchers presented the results of a survey that highlighted which barriers the industry had been facing as it implemented AWP. Some examples of the AWP implementation barriers presented included lack of clear implementation strategy, inconsistent terminology, need for standardization of work packaging, and lack of guidelines around AWP implementation.

Barriers Identified by RT-319

RT-319 identified the primary difficulties faced during AWP implementation. The most common difficulties found during this research were change inertia, lack of buy-in, lack of scope freeze, late engineering deliverables, and poor control process. More details can be found in the RT-319 documents published by CII (CII/COAA 2015; CII/COAA 2015a; O'Brien and Ponticelli 2016).

Preliminary List of Barrier Categories Brainstormed by RT-DCC-04

During its kick-off meeting (January 23–24, 2019), RT-DCC-04 brainstormed a preliminary list of barrier categories, based upon the experience of team members. RT-DCC-04 used these barriers again later as it composed the final list of barriers for use in the survey.

AWP Practices and Components

The RT-DCC-04 research built on materials and tools from RT-272 (CII/COAA 2013; CII/COAA 2013a; CII/COAA 2013b) and the Workface Planning Scorecard proposed by COAA (COAA 2013). RT-DCC-04 analyzed the questions in all of the assessment tools and scorecards to ensure that the AWP practices and components were identified.

RT-272 Audit Tool by Phase

The AWP Audit Tool by Phase in Volume II of IR-272 was designed to assess conformity to the AWP processes at each stage of the project. It was primarily intended for use by the owner, but it can also be used by other parties to identify gaps in AWP implementation. The complete version of the tool can be found in IR-272, Volume II (CII/COAA 2013a).

Workface Planning Scorecard

The Workface Planning Scorecard, developed by COAA, was used as a reference for the development of the RT-272 Audit Tool by Phase just discussed. Some items in the Workface Planning Scorecard were not included in the RT-272 Audit Tool by Phase but may be relevant to DCC implementation of AWP. The complete version of the tool can be found in COAA's *Advanced Work Packaging & Workface Planning Scorecard* (COAA 2013).

RT-272 Case Study Questionnaire

RT-272 presented a questionnaire about AWP practices and components. The questions focused around project background and characteristics, workface planning practices, and project performance. All questions had binary answers (i.e., yes or no) and space for comments about the questions. The complete version of the tool can be found in IR-272, Volume II (CII/COAA 2013a).

RT-272 AWP Project Definition Assessment Tool

The AWP Project Definition Assessment Tool helps project teams assess readiness before implementing AWP in a specific project. The score of the questions is divided into five levels. The complete version of the tool can be found in IR-272, Volume II (CII/COAA 2013a).

Chapter 4

AWP Implementation Plans and Maturity Levels

RT-DCC-04 analyzed the AWP implementation plans and maturity-level ratings obtained from the survey responses. Of the 68 survey respondents, 64 indicated that their company had implemented AWP. Of the four respondents who had not, one was a contractor, one an owner, and two were service providers. When the team asked these four respondents why their companies had not implemented AWP, they offered the following reasons:

“Company does not recognize the value of implementing AWP.”

“Implementing AWP does not appear cost-effective for the company. The cost of changing engineering and procurement deliverables and the additional staff necessary to implement AWP is not suitable for the company at the moment.”

AWP Implementation Plans

The team asked the representatives of the 64 companies that implement AWP to answer several additional questions. Their responses to a question about where their companies apply or intend to apply AWP demonstrated that AWP is being used globally (see Figure 6). A question about each company’s scalability approach to applying AWP showed that respondents considered AWP applicable to projects of all sizes (see Figure 7).

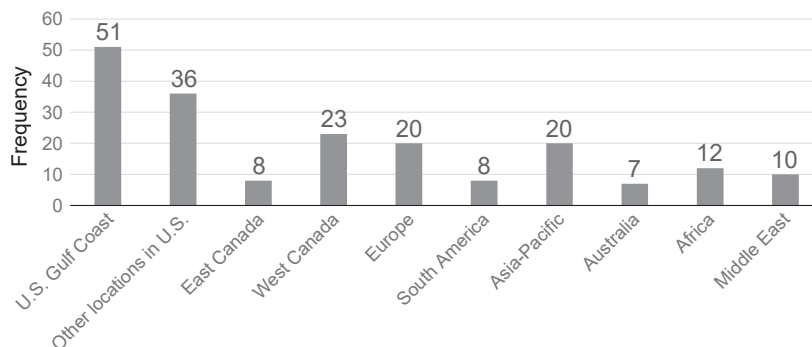


Figure 6. Where the Company Applies or Intends to Apply AWP

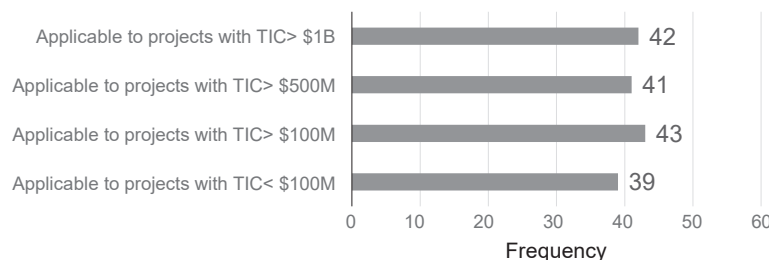


Figure 7. AWP's Applicability to Projects of Various Sizes

AWP Implementation Maturity Levels

In order to analyze the maturity levels of the companies, the researchers calculated a maturity score for each company. Each final score was an average of the company's AWP maturity, indicated across all five dimensions proposed by the RT-272 maturity model. Table 3 shows how this maturity score was calculated.

Table 3. How RT-DCC-04 Calculated a Company's Maturity Score

Company	MM1 – View of AWP	MM2 – AWP Implementation Strategy	MM3 – Work Processes and Deliverable	MM4 – Culture and Performance Metrics	MM5 – Training and Support	Score
Company A	2.0	3.0	2.5	3.0	2.0	2.500

After obtaining a maturity score for each company relative to the RT-272 model, the researchers analyzed each maturity level by considering the role that the company took on projects (i.e., contractor or owner). The team calculated a score for each group through the weighted average of the frequency of responses for that group. Unlike with each company's maturity analysis, the team calculated a separate group score for each dimension, instead of combining the five into one total score. Hence, each group had a different score for each of the five proposed dimensions. Table 4 gives an example of the group maturity calculation for one dimension (View of AWP Potential and Benefits). Note that the numbers in the second column reflect the number of responses at each level. For example, five respondents to the survey marked Level 1 for "View of AWP Potential and Benefits (Frequency)."

Table 4. How a Group Maturity Score Was Calculated

Maturity Level	View of AWP Potential and Benefits (Frequency)
1 (Low)	5
1.5 (Between Median and Low)	4
2 (Median)	7
2.5 (Between Median and High)	5
3 (High)	7
Weighted Score	2.09

The team analyzed the maturity of the companies in three ways (shown in Tables 5–7):

- **Overall maturity** included responses from owners and contractors.
- **Contractors' maturity** only accounted for companies that took the role of contractor.
- **Owners' maturity** only accounted for companies that took the role of owner.

Table 5. Maturity Model Scores – All (Owners + Contractors) (n= 25)

Maturity Level	View of AWP Potential and Benefits (Frequency)	AWP Implementation Strategy (Frequency)	Work Processes and Deliverables (Frequency)	AWP in Company Culture and Performance Metrics (Frequency)	Training and AWP Support (Frequency)
1	4	7	4	7	7
1.5	4	8	8	7	10
2	7	4	5	5	5
2.5	4	3	5	5	2
3	6	3	3	1	1
Weighted Score	2.08	1.74	1.90	1.72	1.60

Table 6. Maturity Model Scores – Contractors (n= 14)

Maturity Level	View of AWP Potential and Benefits (Frequency)	AWP Implementation Strategy (Frequency)	Work Processes and Deliverables (Frequency)	AWP in Company Culture and Performance Metrics (Frequency)	Training and AWP Support (Frequency)
1	2	4	1	4	3
1.5	2	3	5	3	7
2	3	3	3	3	2
2.5	3	2	3	3	1
3	4	2	2	1	1
Weighted Score	2.18	1.82	2.00	1.79	1.64

Table 7. Maturity Model Scores – Owners (n= 11)

Maturity Level	View of AWP Potential and Benefits (Frequency)	AWP Implementation Strategy (Frequency)	Work Processes and Deliverables (Frequency)	AWP in Company Culture and Performance Metrics (Frequency)	Training and AWP Support (Frequency)
1	2	3	3	3	4
1.5	2	5	3	4	3
2	4	1	2	2	3
2.5	1	1	2	2	1
3	2	1	1	0	0
Weighted Score	1.95	1.64	1.77	1.64	1.55

By displaying the results in these three ways, the research team was able to analyze differences in maturity between the contractors and the owners in the five dimensions:

- Both owners and contractors showed a higher maturity level on “View of AWP Potential and Benefits” and a lower maturity level on “Training and AWP Support.”
- Both owners and contractors had a higher maturity in terms of AWP potential and benefits, and a lower maturity in terms of AWP training and support. That meant that the companies tended to have knowledge about AWP, understood its benefits, and knew the concepts behind AWP. However, they tended to lack an understanding of how to apply and put into practice all of the AWP concepts.
- The maturity model scores also gave the research team an idea of the areas where companies were struggling most. This information could help to identify which areas represent opportunities for improvement. Finding opportunity areas is going to help this research to continue its task of promoting the use of AWP at the industry level. According to the maturity model scores, the main areas where the companies were struggling were training, metrics, and company culture.

These findings from the maturity model reflect what the RT-DCC-04 research found in the sections that follow. The areas where the maturity level was lower were directly related to the AWP implementation barriers that respondents ranked as “major.”

Chapter 5

Analysis of AWP Implementation Barriers

As Chapter 2 showed, RT-DCC-04 gathered data on the barriers to implementing AWP from three different sources:

1. Multiple-choice questions, where a quantitative analysis was used
2. Open-ended survey questions, where qualitative analysis was conducted
3. Interview questions, where a qualitative analysis was performed to obtain the section findings

This chapter will explain how these quantitative and qualitative analyses were conducted and present their findings related to the barriers.

Quantitative Analysis – Multiple Choice Questions

For the quantitative data, RT-DCC-04 developed a scoring system that would conform to the research objectives. The team asked participants to rank the barriers in a multiple-choice question, then explored ranking processes that delivered four different scores. Table 8 shows the method the team used to calculate each score.

Table 8. Four Methods RT-DCC-04 Used to Score Barriers

Score 1	Score 2	Score 3	Score 4
Weighted average excluding None and N/A responses <i>Major = 3, Moderate = 2, Minor = 1</i>	Number of Major Barriers Total Number of Major, Moderate, and Minor Barriers	Weighted average of all responses <i>Major = 3, Moderate = 2, Minor = 1</i>	Number of Major Barriers Total Number of Responses

Table 9 gives an example of how the same data delivered four barrier scores. In this example, 19 respondents considered Barrier 1 to have a major impact on the AWP implementation, 19 thought it had a moderate impact, 10 said it had a minor impact, 3 felt it had no impact, and 5 judged that the barrier was not applicable to their procedures. Once RT-DCC-04 had identified that Score 1 was most relevant to the research objectives, the team ranked the top barriers by Score 1.

Table 9. An Example of How the Team Calculated Barrier Scores

<i>Barriers in the Survey</i>	<i>Major</i>	<i>Moderate</i>	<i>Minor</i>	<i>None</i>	<i>N/A</i>	Score 1	Score 2	Score 3	Score 4
Barrier 1	19	19	10	3	5	2.19	40%	1.88	34%

To give different perspectives of the chief barriers, the team analyzed the data in the following ways:

- Overall top barriers
- Top barriers divided by owners and contractors' responses
- Top barriers divided by home office and field office personnel's responses
- Top barriers considered by three levels of AWP implementation maturity (i.e., high, median, and low)

After analyzing the data and identifying the top barriers, RT-DCC-04 created categories to classify the barriers. Through this classification, the researchers aimed to provide a more streamlined view of areas to improve, and thereby to get a better understanding of which areas needed more support from CII to facilitate AWP implementation. Table 10 gives the categories of barriers that the team developed.

Table 10. Categories of Barriers

<i>Categories of Barriers</i>	
	AWP maturity level, resource availability, and AWP understanding
	Integration of AWP with engineering
	Company unconvinced of AWP benefits or not interested in implementing AWP
	Alignment and integration of AWP with existing company processes and systems

Table 11 shows the top barriers according to Score 1, with barrier categories indicated where appropriate. The overall main barriers were mostly related to the following topics:

- The maturity level of AWP implementation
- The availability of resources to implement AWP
- The companies' understanding of AWP
- The integration of AWP with engineering
- The integration of AWP into existing company processes and systems

However, as Table 11 shows, the top overall barriers were related to only the first two barrier categories.

Table 11. Overall Top Barriers in the Survey

<i>Barriers in the Survey</i>		<i>Major</i>	<i>Moderate</i>	<i>Minor</i>	<i>None</i>	<i>N/A</i>	<i>Score 1</i>
?	49. Low level of AWP maturity among contractors	18	19	10	3	5	2.17
?	18. Not enough qualified resources for implementing AWP	20	21	12	5	1	2.15
⚙	57c. External push-back from engineering design/procurement contractor	13	14	9	6	10	2.11
⚙	57b. External push-back from engineering design contractor	13	16	10	6	7	2.08
⚙	39. Design engineering organization not supportive of AWP	14	18	12	9	3	2.04
⚙	57d. External push-back from engineering design/procurement/construction contractor	12	10	11	7	13	2.03
?	3. Lack of clear understanding of AWP methodology and processes	15	25	14	4	1	2.02
	57a. External push-back from owner	10	9	10	14	10	2.00
	12. Contractor does not buy in early enough	17	10	18	7	7	1.98
	54. AWP program is not owner-driven	10	13	11	14	7	1.97
	50. Poor integration of AWP information system with other corporate systems	10	28	12	2	3	1.96
	10. Lack of alignment between AWP implementation strategy and field execution	13	16	15	13	3	1.95
	11. Lack of alignment between AWP and front end planning	11	23	14	8	3	1.94
	55. Lack of financial incentives to improve execution efficiency	10	15	13	14	3	1.92
⚙	26. Engineering design sequence not able to match construction sequence	14	17	18	5	4	1.92
<i>Categories of Barriers</i>							
?	AWP maturity level, resource availability, and AWP understanding						
⚙	Integration of AWP with engineering						
✗	Company unconvinced of AWP benefits or not interested in implementing AWP						
	Alignment and integration of AWP with existing company processes and systems						

Table 12 depicts the top barriers from the data, divided to isolate contractors and owners.

Table 12. Contractors and Owners' Top Barriers

Contractors		
Barriers		Score
	9. Lack of ongoing alignment among owner, contractors, suppliers, and others	2.23
II	10. Lack of alignment between AWP implementation strategy and field execution	2.21
?	18. Not enough qualified resources for implementing AWP	2.19
	57a. External push-back from owner	2.17
⚙	57c. External push-back from engineering design/procurement contractor	2.17
⚙	22. Construction company not available to provide timely path of construction input	2.09
⚙	57b. External push-back from engineering design contractor	2.08
⚙	39. Design engineering organization not supportive of AWP	2.07
	54. AWP program is not owner-driven	2.07
II	14. Owner does not include clear AWP requirements in the contract	2.06
Owners		
Barriers		Score
?	49. Low level of AWP maturity among contractors	2.45
?	18. Not enough qualified resources for implementing AWP	2.23
?	3. Lack of clear understanding of AWP methodology and processes	2.11
	57g. External push-back from subcontractor	2.06
⚙	57c. External push-back from engineering design/procurement contractor	2.06
II	50. Poor integration of AWP information system with other corporate systems	2.00
⚙	57b. External push-back from engineering design contractor	2.00
⚙	57d. External push-back from engineering design/procurement/construction contractor	2.00
	48. Lack of training	1.96
⚙	39. Design engineering organization not supportive of AWP	1.95
Categories of Barriers		
?	AWP maturity level, resource availability, and AWP understanding	
⚙	Integration of AWP with engineering	
X	Company unconvinced of AWP benefits or not interested in implementing AWP	
II	Alignment and integration of AWP with existing company processes and systems	

The main barriers for combined contractors and owners were mostly related to AWP awareness, integration with engineering, and integration between AWP and existing procedures. For owners alone, the top three barriers were related to AWP maturity, resource availability, and AWP awareness. For contractors, integrating AWP with engineering was a more prevalent barrier.

Table 13 gives an analysis of the top barriers, according to a separate consideration of home office and field office personnel.

Table 13. Home and Field Offices' Top Barriers

Home Office		
Barriers		Score
? 49. Low level of AWP maturity among contractors		2.21
? 18. Not enough qualified resources for implementing AWP		2.18
⚙ 57c. External push-back from engineering design/procurement contractor		2.11
⚙ 57b. External push-back from engineering design contractor		2.06
? 3. Lack of clear understanding of AWP methodology and processes		2.04
⚙ 39. Design engineering organization not supportive of AWP		2.03
57a. External push-back from owner		2.00
II 50. Poor integration of AWP information system with other corporate systems		1.98
55. Lack of financial incentives to improve execution efficiency		1.97
⚙ 57d. External push-back from engineering design/procurement/construction contractor		1.96
Field Office		
Barriers		Score
⚙ 22. Construction company not available to provide timely path of construction input		2.33
23. Too many unknowns to effectively sequence CWP's well in advance		2.29
⚙ 57d. External push-back from engineering design/procurement/construction contractor		2.29
II 11. Lack of alignment between AWP and front end planning		2.25
54. AWP program is not owner-driven		2.25
⚙ 26. Engineering design sequence not able to match construction sequence		2.22
II 40. Lack of inter-organizational coordination following a scope change		2.20
II 52. Manual or paper-based IWP management system is inefficient for the project size		2.14
12. Contractor does not buy in early enough		2.13
⚙ 39. Design engineering organization not supportive of AWP		2.13
Categories of Barriers		
? AWP maturity level, resource availability, and AWP understanding		
⚙ Integration of AWP with engineering		
X Company unconvinced of AWP benefits or not interested in implementing AWP		
II Alignment and integration of AWP with existing company processes and systems		

The top barriers from survey respondents working in the home office were more focused on AWP awareness, while the top barriers from those working in the field office were more focused on integrating AWP with engineering. This difference shows that the field office was struggling more with the execution of AWP procedures, while the home office was struggling more with understanding AWP.

Table 14 separates the top barriers by AWP implementation maturity level.

Table 14. Top Barriers for Each Maturity Level

High Maturity		
Barriers		Score
⚙️	39. Design engineering organization not supportive of AWP	2.50
⚙️	57b. External push-back from engineering design contractor	2.09
⚙️	57c. External push-back from engineering design/procurement contractor	2.09
⚙️	57d. External push-back from engineering design/procurement/construction contractor	2.09
	10. Lack of alignment between AWP implementation strategy and field execution	2.08
	12. Contractor does not buy in early enough	2.00
⚙️	22. Construction company not available to provide timely path of construction input	2.00
	54. AWP program is not owner-driven	2.00
	57h. External push-back from suppliers	1.92
	57a. External push-back from owner	1.90
Median Maturity		
Barriers		Score
?	49. Low level of AWP maturity among contractors	2.46
?	18. Not enough qualified resources for implementing AWP	2.19
	50. Poor integration of AWP information system with other corporate systems	2.12
⚙️	57b. External push-back from engineering design contractor	2.06
?	3. Lack of clear understanding of AWP methodology and processes	2.00
	11. Lack of alignment between AWP and front end planning	2.00
⚙️	57c. External push-back from engineering design/procurement contractor	2.00
	55. Lack of financial incentives to improve execution efficiency	1.95
	56c. Internal push-back from project managers	1.94
⚙️	26. Engineering design sequence not able to match construction sequence	1.92
Low Maturity		
Barriers		Score
✖	4. Expectation of limited (or no) benefits to company from AWP	2.50
	56o. Internal push-back from cost estimators	2.50
✖	6. Company not interested in implementing AWP	2.43
✖	7. Awaiting more industry AWP project results before implementing	2.38
✖	46. Do not need AWP because current project performance/results are good enough	2.38
	12. Contractor does not buy in early enough	2.36
?	29. Need (or perceived need) for additional project team members for AWP	2.30
⚙️	39. Design engineering organization not supportive of AWP	2.22
	56k. Internal push-back from general foremen	2.21
	56m. Internal push-back from field crews	2.21
Categories of Barriers		
?	AWP maturity level, resource availability, and AWP understanding	
⚙️	Integration of AWP with engineering	
✖	Company unconvinced of AWP benefits or not interested in implementing AWP	
	Alignment and integration of AWP with existing company processes and systems	

A company's AWP implementation maturity level often aligned with the barriers it was prepared to address:

- The high-maturity companies faced barriers more closely connected with integrating AWP with engineering. This shows that the high-maturity companies have recognized the benefits of AWP and are now focused on resolving issues connected with implementing AWP.
- The median maturity companies presented a mix of barriers related to awareness and barriers related to integration with engineering. These companies are still in the process of implementing AWP. Only part of a company has an established awareness of AWP and understands the barriers. And, because these companies have commenced implementing AWP, they also recognize some barriers related to AWP procedures.
- The low-maturity companies are encountering more barriers that come with being unconvinced of AWP's benefits or of being uninterested in implementing AWP – another interesting finding. If a company fails to recognize the value of implementing AWP, it will not invest in the resources necessary to implement it.

These tables only examined the top barriers for each category. The full lists of ranked barriers for all of these analyses are presented in Appendices C through J.

Qualitative Analysis – Open-ended Questions

The researchers used an open coding method to analyze the responses to the open-ended survey questions. The objective of the coding system was to group the high number of responses for any specific question and thereby to provide a more concise analysis of the qualitative data. The system grouped responses that contained the same idea, but were worded differently by the various respondents. It permitted a more efficient study and allowed the researchers to analyze the frequency of a proposed idea. The team used this system to analyze the open-ended questions for both the top barriers faced in AWP implementation and the potential solutions to overcome these barriers. Table 15 shows a list of the barriers that respondents mentioned in the open-ended questions, but that the team did not include in Table 1.

Note that just because a barrier was mentioned with higher frequency, that does not necessarily mean that this barrier has a greater impact on AWP implementation than another barrier that was mentioned less frequently. Instead, more frequent mentions mean that this company is more aware of this barrier than the others. Thus, the frequency of mentions is unrelated to severity, but it is related to awareness.