ADVANCED WORK PACKAGING AS EMERGING PLANNING APPROACH TO IMPROVE PROJECT PERFORMANCE: CASE STUDIES FROM THE INDUSTRIAL CONSTRUCTION SECTOR.

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Abstract: Despite the progress made in the development of scheduling techniques and tools, the industrial construction sector is frequently characterized by informal and unstructured procedures during initial planning stages. This results in planning deliverables that are scarcely aligned across the different business divisions and poorly structured to support field operations. Advanced Work Packaging (AWP) methodology consists in an enhanced project breakdown structure that prescribes an organized planning approach, aiming at the alignment between construction, engineering, and procurement disciplines since the preliminary planning phase. AWP is an emerging planning approach in the industrial construction sector and the present article is aimed at exploring AWP impact on project performance. Research methodology is based on multiple case studies concerning two industrial construction projects. The case studies involved the construction of projects with identical scope, one with and one without AWP implementation. These case studies were performed at the same time, in neighboring sites, and by the same project participants, thus representing reliable units of analysis to investigate AWP impact. Findings show that AWP implementation is related to improved performance in terms of project cost, schedule, quality, and safety. The present article contributes to the validation of an emerging project planning methodology and highlights the criticality of the early planning phase, which systematic characterization represents a valuable and still under-explored research avenue.

1 INTRODUCTION

Recent research performed by the Construction Industry Institute has highlighted the poor execution performance in the industrial project sector, where almost 70% of projects exceeded 10% variation from expected cost and schedule values (CII, 2012). This poor performance is inescapably tied to the lack of reliability of the planning process (Gibson et al., 2006), which is not able to offer reliable estimates and to manage the increasing complexity of industrial projects (Bosch-Rekveldt et al., 2011).

Among the most common project planning concepts, work-packaging has been extensively used and recommended within Project Management theory to divide the scope of work into manageable units for execution (e.g. PMI, 2004). The erratic adoption and the lack of updated standards for existing work-packaging theory motivated a four-year research project by the Construction Industry Institute (CII) – together with the Construction Owner Association of Alberta (COAA) – aimed at defining and recollecting the current work-packaging best practices in the industrial construction sector. The efforts of this research resulted in a codified and systematic planning approach named Advanced Work Packaging (AWP).
The AWP approach provides a holistic process for work-packaging execution with a project lifecycle orientation, from preliminary planning to system turnover and commissioning (CII IR 272-2 Volume 1, 2012). AWP prescribes an organized planning approach through the continuous alignment between construction, engineering, and procurement disciplines, emphasizing the application of work-packaging concepts beyond field implementation to reach the initial phases of project development. AWP has still an emerging connotation within the industrial construction sector and further empirical evidence is required to demonstrate its beneficial impact and to corroborate the logics underlying this beneficial impact. The objective of present research is to explore AWP role in improving project performance. By pursuing this goal, the researchers started addressing two main challenges of current work-packaging literature, one conceptual and one methodological.

The first main challenge involves the limited attention paid by extant research to early integration between project participants (Yang, 2013). Hence, traditional concepts place most of the emphasis on schedule definition and field implementation activities, almost neglecting the importance of alignment practices during the preliminary planning stage. The present research addressed this challenge by emphasizing the traits and features of AWP that foster initial alignment and integration within the project management team. The second main challenge regards the difficulties of project management literature in providing reliable and replicable empirical evidence (Koskela and Howell, 2002). Isolating the impact of specific techniques or practices is a complex methodological issue that is a direct consequence of project uniqueness, characterized by distinctive environmental conditions, scope, and project participants' interactions (e.g. Aloini et al., 2012). To minimize this issue, the present research identified and analyzed two projects with identical scope, project team, and location that are performed in parallel with- and without-AWP implementation.

The theoretical novelty of the present work resides in the emerging treats of AWP, which challenges the traditional work-packaging approaches towards a more integrated planning process. From a practical perspective, the present article can support construction managers implementing AWP with detailed insights throughout the various project stages.

This paper has the following structure. Section 2 introduces the AWP approach and formulates the research objective. Section 3 highlights research methodology. Section 4 offers and discusses the results. Finally Section 5 is dedicated to conclusions and future research developments.

2 THEORETICAL BACKGROUND

The term "work-packaging" is used to cover "any method of organizing work execution process within the scope of a construction project" (CII IR 272-2, 2013). Despite the widespread adoption of work-packaging principles in the construction industry, extant research has sporadically indicated systematic approaches that are able to effectively integrate the planning and the execution processes (Yeo and Ning, 2006). Previous research "has been devoted to examining the conceptual applicability of the work-packaging concept and applying it as a general managerial tool. Only limited attention has been paid to the actual work-packaging process" (Kim and Ibbs, 1995). This lack of empirical evidence is particularly marked for the industrial construction sector (Azambuja et al., 2014; Jacoby, 2012), so that the underlying work-packaging theory has been considered obsolete and inadequate to effectively execute projects in practice (Choo et al., 1999; Koskela and Howell, 2002). One of the main problems has been identified in the poor integration between the engineering, construction, and procurement disciplines (Goodman and Ignacio, 1999), mainly because of the delayed involvement of project participants during the initial project phases (Gibson et al., 2006).

Since 2009, a research project conducted by the joint effort of CII and COAA has been investigating the work-packaging issue through the analysis of current best practices in the industrial construction sector. The outcome was a framework for AWP that prescribes the breakdown structure of project scope into three main stages (Figure 1): Preliminary Planning/Design, Detailed Engineering, and Construction (O’Brien et al., 2013). Compared to previous work-packaging efforts for the industrial sector – most notably the WorkFace Planning concepts (Ryan, 2009) – AWP shifts the focus to the early planning stages and provides a holistic process for work-packaging execution with a project lifecycle orientation.
During the first stage – Preliminary Planning – the project management team identifies the critical planning elements to achieve a coordinated planning sequence. This sequence is obtained through the iterative definition of work-packaging deliverables. The project is initially broken into a set of Construction Work Packages (CWPs), which define the logical and manageable division of work within the construction scope. CWPs are aligned with the project execution plan and with engineering deliverables or Engineering Work Packages (EWPs). EWPs are enclosed within CWPs, so that engineering and procurement disciplines are delivered to support construction. The identification of EWPs is accomplished by system, eventually crossing CWP boundaries through the positioning of decoupling elements (e.g. valves).

The second stage – Detailed Engineering – builds on and refines the work started during preliminary planning. From an engineering and procurement perspective, the output of this phase includes the detailed specification of EWPs. The breakout of construction work hours for the project is provided at this stage and it enables the resource loading of a Level 3 schedule, which is prepared for engineering (by discipline), for procurement (by commodity and by construction need date), and for construction (by area). The different plans are constantly aligned to ensure consistency.

The third stage – Construction – includes the detailed planning and the execution of operational work-packages, named Installation Work Packages (IWPs) that contain all necessary and pertinent documents in support of the safe and efficient installation for a specific system portion. IWPs are developed by a dedicated AWP Planner, who collect the necessary documentation and ensures the resolution of operation constraints. IWPs are issued to the field three weeks before the starting date and they have to be approved by the frontline personnel, who become accountable for their execution. IWPs are pulled by the responsible superintendent/foreman, adhering in a dynamic manner to construction requirements. After execution, IWPs are controlled by owner representatives, who perform the quality check and update project estimates.

The AWP approach is gaining increasing attention from the industrial practitioners’ community in North America (i.e. through dedicated conferences and communities of practice). However, this approach still requires further rigorous analysis and empirical validation. As various scholars advocated a closer connection between theory and practice in project management (Koskela and Howell, 2002), the present research aims to:

- Provide in-depth insights on the AWP implementation process throughout the three project phases.
- Explore the impact of AWP on key project performance dimensions (cost, schedule, quality, safety).

3 RESEARCH METHODOLOGY

The explorative nature of this research has driven the methodological choice towards a qualitative approach (Yin, 2014). Case-based research has been selected as the most suitable technique to
empirically investigate the research objectives. Hence, multiple case studies are useful to obtain in-depth results on phenomena that are embedded in a complex and uncertain environment (McCutheon and Meredith, 1993), such as the industrial construction sector.

The unit of the analysis of the case studies is the project, which is analyzed from initial scope definition to the completion of field activities. Two industrial projects have been selected because involving the separate construction of identical systems as part of the same project. These systems were also executed in parallel, on contiguous sites, and by the same project companies (different crews but equivalent contractual and incentive structures). The systems can be considered identical apart from AWP adoption. AWP was adopted only for the execution of one system, while the other one was performed with traditional planning approaches. This duplication allowed using a replication logic (Yin, 2014) to isolate as much as possible the impact of AWP on project performance – increasing results reliability.

The first case study involved the construction of the necessary infrastructure to build twelve additional wells on two existing extraction sites in a North Eastern region of the United States. Construction activities were equally divided between the two sites and AWP was implemented only in one of them. The project had a duration of 4 months for a total of 160,000 construction hours. Project scope included also a modularization component for the construction of four pipe-racks. The remoteness of project locations, the limited duration of the construction season, and the high labor demand all necessitated effective integration between construction and engineering. This represented the main motivation for the Owner to test AWP effectiveness.

The second case study involved the construction of the necessary infrastructure to progress mining activities into two sites neighbouring an existing extraction facilities in Alberta, Canada. The project was mainly characterized by intensive civil and piping activities, which included the completion of two dykes and the partial development of a dedicated disposal area. As for the first case study, project activities were equally divided between the two sites and AWP was implemented in only one of them. The project had a duration of 12 months for approximately 1 million construction hours. The Owner decided to implement AWP to improve constraint mitigation during the upfront planning stage.

Table 1 highlights the main characteristics of the two case studies, namely: project sector, scope, construction hours, construction duration, and interviewees’ role.

<table>
<thead>
<tr>
<th>Case Study ID</th>
<th>Sector</th>
<th>Scope</th>
<th>Construction hours</th>
<th>Duration (month)</th>
<th>Interviewees (role*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oil&amp;Gas</td>
<td>Infrastructure (e.g. pipe-racks) to support drilling activities</td>
<td>160,000</td>
<td>4</td>
<td>Project Manager (O) – Superintendent (C) – Engineering Manager (E)</td>
</tr>
<tr>
<td>2</td>
<td>Oil&amp;Gas</td>
<td>Infrastructure (e.g. dykes) to support mining activities</td>
<td>1,000,000</td>
<td>12</td>
<td>Project Manager (O) – Construction Manager (O) – Superintendent 1 (C) – Superintendent 2 (C) – Project Scheduler (E)</td>
</tr>
</tbody>
</table>

*The role can be: Owner (O), Constructor (C), and Engineering (E).

The data collection process involved four main areas: AWP process; project performance; organizational implications; discussion on implementation challenges, and lessons learned. To increase the validity and reliability of the data collection process, the following measures have been adopted:

- The interviews were conducted through a semi-structured questionnaire (Voss et al., 2002). Each interview had a duration of approximately 1 hour. The questionnaire was sent in advance to the interviewees to increase the efficiency of the data collection process.
Multiple informants were consulted for each case study. Interviewees were selected to represent key project participants (see Table 1) – thus taking part to AWP implementation from different perspectives in order to triangulate the results and increase findings reliability (Gibbert et al., 2008).

Each interviewee provided a feedback on case study results to ensure data reliability (Creswell and Miller, 2000).

4 RESULTS AND DISCUSSION

Each case study is reported separately and focuses on:

- The AWP implementation process from preliminary planning to construction.
- The performance differences between the site with-AWP and the site without-AWP.

4.1 Case Study 1

In this first case study, the owner began the definition of AWP procedures during preliminary planning together with the Engineering and the Contractor companies. The goal of this early planning stage was to achieve AWP buy-in and obtain a reliable high-level scope decomposition in accordance with the construction sequence. The owner hired dedicated planners to provide constructability input during the engineering phase.

At the Level 2 Schedule, the project management team defined the deadlines for the development, issuance, and review of CWPs and EWPs. As detailed engineering neared completion, the project management team handed off the remaining planning efforts to the contractor's planning team. Recognizing the value of pre-mobilization planning, the owner brought the contractor's planning personnel to the home office two months prior the initial construction date.

The contractor did not utilize dedicated AWP planners – because of the limited project size – but rather traditional construction field personnel, who were responsible to perform the planning process. These personnel included superintendents and discipline foremen – such as electrical, instrumentation, piping, structural, and scaffolding – that were selected because they would be directly executing IWPs and had substantial planning experience. The planning team dissected the scope of work in accordance to the separate parts of the construction assembly sequence and created IWPs to support this sequence. IWPs were developed to a Level 3 Schedule. IWPs were broken-down by construction areas, module interfaces, and termination points. They were not homogeneous in terms of construction hours, so that different disciplines had IWPs of different size. The project resulted into 40 IWPs. As systems neared completion, the focus shifted from construction by area to system commissioning. Consequently, all IWPs were designed to include turnover specifications.

After planning completion, IWPs were sorted by discipline and issued in total to the responsible foremen. The issuance process was not in line with prescribed methodology that recommends to deliver the packages three weeks before the beginning of field activities. This lump IWP distribution generated a document control management issue, which arose when minor engineering specifications changed and then needed to be updated. The foremen became accountable for work completion and organized IWPs execution into a logical construction sequence. To control working activities, foremen updated a weekly progress spreadsheet, by recording installed quantities. Planning meeting were held weekly between superintendents and project controls personnel to determine project progress. Upon completion, IWPs were returned to the field office to incorporate lessons learned.

In terms of project performance, the interviewees reported various differences between the site with-AWP and the site without-AWP (see also Table 2):

- Cost. Although the project on the site without-AWP was completed on-budget, work stopped several times as a result of ineffective planning. Plans delivered to construction personnel were not
constraint-free and not developed at a sufficient level of detail. This led to inefficient field operations, which were often relocated across different construction areas, compromising field productivity. The site with-AWP completed the project under-budget and with a cost savings of $740,000 in labor. This result was obtained by minimizing the waiting time for materials and drawings for the crews. IWPs were effectively delivered to support construction activities. Moreover, the contractor reported that the inclusion of complete scope portions into specific IWPs allowed the crews focusing on one specific area at the time. As such, productivity was 20% higher than estimates.

- **Schedule.** The project without-AWP was delivered on-schedule. Crews were re-assigned to other tasks when their work was stopped, so that the overall project schedule was maintained. The project with-AWP was completed ahead of schedule, allowing the systems to be placed in service five days earlier than planned. Schedule savings were caused by the improved field productivity of construction operations, which allowed anticipating or parallelizing activities.

- **Quality.** For this project, welding activities represented the biggest portion of field activities so that quality is here measured in relation to this process. The site without-AWP highlighted a 2% weld reject rate, which was in line with contractor’s historical performance. The site with-AWP highlighted a 0% weld reject rate. This performance was linked to the more accurate planning process that is achieved through AWP. On the site without-AWP, welds were performed in the field under the influence of inclement weather, with little or no protection from the external environment. On the site with-AWP, the planning team was able to analyze the locations of field welds during IWP development. This analysis allowed grouping the weld areas together to perform the construction process under temporary shelters. These shelters provided better protection from the environment and, thus, improved process quality. In general, the owner qualitatively reported a reduction of reworks in the site with-AWP, mostly due to reduced scope and engineering changes. Most of the engineering changes were identified and mitigated during detailed engineering, rather than during construction when the impact of changes is higher.

- **Safety.** The site without-AWP reported one recordable injury. This injury was attributed to the re-direction of the crew to another area and to the worker’s self-imposed pressure to complete a scope of work that was unfeasible. The site with-AWP reported zero recordable injuries. This performance was attributed to improved risk identification and mitigation during IWP development and execution. Because the work was better planned, there was significantly less re-direction of crews on-site due to unforeseen constraints. Also, safety considerations were included into each IWP, so that the foremen were able to increase crew’s safety awareness during the daily briefing before operations started.

<table>
<thead>
<tr>
<th>Table 2: Performance from Case Study 1</th>
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</thead>
<tbody>
<tr>
<td><strong>Performance</strong></td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>Schedule</td>
</tr>
<tr>
<td>Quality</td>
</tr>
<tr>
<td>Safety</td>
</tr>
</tbody>
</table>

**4.2 Case Study 2**

In this second case study, the owner set up an AWP team together with members from the Owner, Engineering, and Contractor companies during the preliminary planning phase. The aim of the team was to obtain early alignment on AWP planning procedures and definitions. During the preliminary planning process, the AWP team divided the project scope into CWPs and integrated the various plans accordingly, checking for scope gaps and overlaps. Involving the contractor at this stage was fundamental to include constructability principles since the very beginning of the design process.
Subsequently, CWPs and EWPs were finalized and integrated in accordance with the scope and the complexity of construction activities. For example, the piping discipline allowed including many decoupling points across the construction areas (e.g. valves), so that one CWP typically included multiple EWPs. For other disciplines, such as electro-mechanical that is characterized by a larger amount of work-hours per system, boundary definition was more problematic and one CWP might have contained a single EWP. The planning team performed constraint minimization for every CWPs and EWPs, ensuring the definition of long-lead time items and turnover sequence. Also, major equipment requirements were identified and evaluated at this stage.

After the generation of EWPs, the detailed planning phase was managed by the contractor and supervised by the owner. Most involved organizational roles were: Superintendents, Materials Coordinators, and AWP Planners. The role of Owner’s AWP Planners was oriented at the support and coordination of the detailed planning process. CWPs were divided into multiple IWPs following the “one crew – one shift” principle. A shift included 10 working days and approximately 2000 working hours. IWPs were completed three weeks before the start of construction. Then, they were issued to Superintendents one week before the construction date to check and approve the documentation. The progress of each IWP was controlled on a daily basis by Foremen and Owner’s representatives through specific scorecards.

The comparison between the two sites (with- and without-AWP) highlighted substantial differences in each performance dimension. Results are described below and highlighted in Table 3:

- **Cost.** The trend for the project without-AWP resulted in budget overruns for $100,000. The project with-AWP was concluded 10% under budget. The owner reported that AWP allowed a more precise and accurate budget definition. The contractor highlighted an increased profitability related to AWP implementation. The profit for the project with-AWP was approximately three times higher (300% increase) compared to the project without-AWP. Such profit increase was mainly due to the better utilization of major equipment.

- **Schedule.** At the time of the interviews, the project with-AWP was concluded on schedule while the project without-AWP was still requiring three months of work. This delay was due to the unsophisticated schedule definition that took place only at a macro-level and that was supported by unsophisticated paper-based tools. The lack of transparency and the poor definition of details resulted in schedule overrun and to consequent reactive measures to cope with it. On the other site, AWP implementation required the contractor to provide accurate and reliable schedule estimates for IWPs. Hence, the contractors had to review, agree, and sign each IWP.

- **Quality.** The owner reported that the site without-AWP was characterized by a lack of consistent upfront planning that resulted in poor control over site activities. The contractor provided a large amount of Request For Information (RFIs), opposing the sequence and the feasibility of operations that resulted in widespread delays and reworks. The site with-AWP highlighted a smaller number of field reworks. Hence, the sequential release of IWPs allowed mitigating the effect of delays and errors by reducing the variability of field activities, so that each IWP was shielded by the variations occurring on other work-packages. The site with-AWP was also characterized by a smaller number of RFIs, which shifted from the execution to the planning phase when their impact on project cost and schedule is substantially minor.

- **Safety.** After one million hours, zero safety incidents were recorded for the project with-AWP. This result was particularly relevant if compared with the trend of the site without-AWP, which consisted of a recordable injury every month. The structure of IWPs constrained the workforce to focus on a single area, reducing useless and dangerous movements around the site. Also, IWPs prescribed that materials and equipment had to be cleared away from the working area after each shift, providing a cleaner and safer jobsite. AWP procedure was used to influence psychologically the workforce by highlighting safety rules and procedures at the very first chapter of each IWP. Superintendents and foremen got used to think to safety since the beginning of construction activities.
Table 3: Performance of Case Study 2

<table>
<thead>
<tr>
<th>Performance</th>
<th>Without-AWP</th>
<th>With-AWP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$100.000 over budget</td>
<td>$1.5 million below budget</td>
</tr>
<tr>
<td>Schedule</td>
<td>3 months delay</td>
<td>On schedule</td>
</tr>
<tr>
<td>Quality</td>
<td>RFIs paralyzing operations</td>
<td>RFIs solved before operations</td>
</tr>
<tr>
<td>Safety</td>
<td>12 recordable incidents</td>
<td>0 recordable accident</td>
</tr>
</tbody>
</table>

4.3 Discussion

The two case studies highlighted many commonalities but also differences with regard to AWP implementation procedures (e.g., lead-time before issuing IWP to the field, level of owner involvement during IWP development). In both case studies, however, AWP emerged as an important factor that contributed to achieve consistent project performance improvements. These improvements have been directly related to AWP adoption by the various interviewees, who stressed the importance of implementing systematic procedures to decompose project scope in a systematic and integrated since the initial planning phase.

Besides the quantitative improvements in terms of key performance dimensions, the interviewees reported additional “qualitative” benefits related to AWP:

- **Integration between Construction and Engineering.** The involvement of construction representatives since the initial planning phase allowed including consistent constructability input to the whole project sequence. The owners acknowledged higher collaboration between construction and engineering as well as between different construction disciplines (e.g., electrical and mechanical). The early involvement of engineering and construction representatives shaped a proactive team culture that benefited from the know-how of both departments especially during the constraint minimization process.

- **Execution Accountability.** AWP methodology required the contractors to provide accurate estimates for the execution of each IWP. Contractors, in exchange, received a complete and constraint-free documentation to execute IWP. To foster accountability, Superintendents participated to the development of the same IWP that they would execute in the field. They were able to edit, negotiate and correct the construction plans, taking ownership of scope execution by signing each IWP before the beginning of field activities.

- **Workforce Retention.** AWP was credited for lower employee turnover rates within craft personnel in both case studies. Lower turnover rates for the projects with-AWP were attributed to three main factors. First, the extensive training activities performed on AWP topics resulted in higher workforce engagement. Second, the development of a safe and organized construction environment enhanced workers’ satisfaction. Third, the early involvement of constructors made them feel part of the team, increasing their commitment to the project with a proactive role.

Both owner companies reported that the primary difference between AWP and traditional planning methods was the ability to identify and resolve construction constraints prior to field mobilization. However, AWP implementation did not come “effortless” and every company had to overcome consistent change resistance at the functional and at the inter-organizational level. In both case studies, the owner was the main driving subject to push for AWP adoption, which propagated from the final risk-taker (the owner) to other project participants (Engineering and contractors). Hence, interviewees underlined that AWP has to be fully supported at the various hierarchical levels to be effective, from top-management to craft personnel. The interviewees reported that the inclusion of AWP guidelines into the contractual terms fostered personnel buy-in. This contractual inclusiveness should be supported by a dedicated AWP training process in order to avoid that procedures are adopted only for bureaucratic purposes.
5 CONCLUSIONS

This research is aimed at providing empirical evidence of the performance improvements related to AWP implementation. The results of the case studies highlighted that the projects adopting AWP performed better than the projects without AWP in terms of cost, schedule, quality, and safety performance. The reason for this improvement can be traced back to the more systematic planning process undertaken since the initial project development phase. The early involvement of key stakeholders resulted in a reliable set of plans that are iteratively decomposed and delivered to support construction activities. Identifying and solving project constraints – such as materials and engineering drawings availability – fostered the productivity of field activities by reducing the amount of waiting time and the subsequent reallocations of crews to unplanned activities.

From a theoretical perspective, the present article highlighted the shortcomings of current work-packaging literature and investigated the applicability of AWP as an emergent approach for the industrial construction sector. AWP contributes to previous research by extending the traditional work-packaging principles to the early planning stages. This approach enhances the development of collaborative relationship between project participants, providing further evidence on the importance of early integration practices for Construction Management literature. From a practical perspective, the present article provides in-depth details to Construction Managers on successful AWP implementation. This research highlights empirical results from real industrial projects that can be used to replicate AWP benefits. Lessons learned are drawn for every key participant: the owner should be the responsible and the most committed subject driving the implementation process; engineering should modify the traditional way of issuing deliverables to construction by providing complete and timely EWP; contractors should proactively participate to the planning process and take accountability for the execution of field activities.

The main limitation of present article resides in the size of the case study sample. In-depth findings have been preferred to generalizability. Another limitation can be found in the assumption that the only difference between the site with-AWP and without-AWP was the planning approach itself. Although there might be additional factors explaining the performance variance (e.g. construction crews’ skills), every interviewee linked the root cause of performance improvement to AWP implementation, providing convincing and consistent justification.

Future research developments could be oriented at increasing findings generalizability by performing additional case studies in different construction sectors, such as power or commercial. A second potential development could involve the definition of specific performance metrics to measure the “goodness” or the “maturity” of AWP implementation. The comparison between different levels of AWP implementation with different levels of project performance would represent an important contribution to further validate this relationship. Finally, the case studies highlighted that AWP implementation is a complex and resource-consuming process that involves widespread change management implications. A third research development could investigate in details the implementation challenges related to AWP.

Acknowledgements

The present research has been funded by the Construction Industry Institute. We are grateful for this support. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Construction Industry Institute.

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