AWPIC: Advanced Work Packaging Improvement Canvas

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Abstract –

Advanced Work Packaging (AWP) is an innovative planning and control method for industrial projects with known parameters that allow organizations to transform the way they plan and control industrial construction projects. As the implementation of AWP is gradual, organizations are constantly looking to improve their practices. However, several organizations struggle with change, making decisions, and taking action. Every change effort impacts a wide array of internal and external stakeholders, and the lack of standard procedures to help organizations effectively navigate a change by making informed decisions and acting on those decisions impedes the progress and growth of the organization. This paper contributes to the notion of decision-making in the construction industry by presenting an "Advanced Work Packaging Improvement Canvas" (AWPIC). AWPIC allows organizations to improve their current AWP practices and transform their businesses by mapping the essential elements that organizations must consider to facilitate the change dialog internally and move toward the desired future state. The paper describes the theoretical underpinnings that embody AWPIC, then introduces AWPIC, and explains its six building blocks: Current State, Problem, Future State, Solution, Investment and Value Creation Analysis, and Action Plan and Follow-Up. AWPIC is developed with the intent to present a holistic framework for improvement and change processes and increase standardization in the industry.

Keywords –

AWP; Improvement; Business Process Reengineering; Canvas

1 Introduction

In a volatile, uncertain, and ambiguous environment, construction stakeholders are pressured to successfully complete complex construction projects with strict budgets and tight timelines. The success of the construction project depends on the effectiveness of planning and control systems [1,2]. However, in the construction management body of knowledge, the topic of planning and control is considered among the areas in need of improvement in the construction industry [3]. This has yielded various research efforts that have been conducted to develop robust planning and control systems such as work packaging, Last Planner System®, Takt-Time Planning, activity-based methodology, and location-based methodology [4–6].

In industrial construction, and with the increasing project complexity and lack of predictability, Advanced Work Packaging (AWP) was developed as a planning and control method for industrial projects [7]. AWP is an innovative construction-driven process that is based on existing work packaging practices and industry practices [1]. The concept of AWP can be traced back to the1990s, but it was scientifically, formalized in 2009 through research conducted by the Construction Industry Institute (CII) [8,9]. Research on AWP was first launched in Northern America, and soon later, the implementation of AWP expanded and various countries including Peru, Brazil, Argentina, Spain, Norway, South Africa, Nigeria, Saudi Arabia, India, Thailand, China, South Korea, Australia, and Indonesia began integrating AWP into their industrial projects [9].

AWP is formally defined as "a project framework to divide project scope into manageable portions of work for planning and execution to achieve improved productivity and increased predictability. AWP incorporates agile and lean construction methodologies – empowered through automation technology – to optimize capital projects across the entire asset lifecycle" [9]. AWP is also a planning and control system for all stakeholders including the owner, engineer, contractor, subcontractors, vendors, and operators [1,10].

Two key concepts behind AWP include optimizing workflow by integrating discrete packages of work across disciplines into a synchronized plan that will be executed by forepersons and aggressively and collaboratively aligning teams to make that work ready by removing all constraints that would prevent that work from being executed without interruption according to that plan [11]. This requires an effective team that will drive alignment across all key functional groups (design, engineering, procurement, construction, commissioning & start-up) and an integrated supply chain [12].

Readiness gates are set up to ensure work can be released to downstream team members through collective go/no-go decision-making supported by enabling technologies that better inform teams of current conditions to support better decision-making [13].

AWP studies have shown that the implementation of AWP on construction projects results in numerous benefits including improved safety awareness and performance, reduced cost, improved labor productivity, reduced rework, improved overall project cost and schedule predictability, better alignment among stakeholders from planning through construction, and improved overall project quality [7,8,14]. Moreover, with the increased use of AWP on industrial projects, it was found that the level of implementation of AWP practices varies among stakeholders and across projects [1]. [1] developed an AEP maturity assessment form to assist construction stakeholders in evaluating the extent to which an AWP practice of a given project phase is implemented. Additionally, [15] developed an AWP capability assessment tool that enables a project or organization to assess its current state capabilities and desired future state capabilities.

While understanding the shortcomings of current practices and determining the desired future state is instrumental for an organization to begin its journey toward improvement, organizations struggle to structure and institutionalize the change effort [16]. Some organizations wrestle with decidophobia where the fear of making decisions takes over and prevents the organization from moving forward [17]. Other organizations do not provide a collaborative environment that supports change [18]. Organizations, however, are acknowledging that the cost of inaction is far greater than the cost of action. Thus, there is a need to equip organizations with the right decision-making tools to develop a roadmap or execution strategy to attain their desired future state [19].

While the existing research work on AWP discusses AWP practices and benefits, research does not present a standardized methodology to assist AWP organizations to improve their current state and reach a desired future state. This paper builds on the work conducted by [15] and aims to advance strategic thinking and assist construction stakeholders in making incremental improvements in their AWP practices and implementation. The objective of this paper is to develop a simple, yet holistic "AWP improvement Canvas (AWPIC)" that maps the essential elements that organizations must consider to facilitate the change dialog internally and move toward the desired future state. While not discussed in this paper in detail, those essential elements can be described as a blend of *people* who are at the center of any change in construction organizations, *processes* that must be analyzed and re-engineered to remove waste and enhance their flow, *technology* that can transform tasks and add value to the desired outcome, and *culture* that would require collaboration, communications, and willingness to continuously improve among all related stakeholders [20,21].

2 Theoretical Underpinnings

Projects are executed based on a constant flow of decisions, the timing of those decisions, who makes those decisions, how they are made (collaboratively, committee, individually, etc.), and the implications of those decisions based on the quality and richness of the information used to make that decision [20]. Thus, the decision to improve from a current state to a future state must be driven by scientific thinking [22]. A search on Google Scholar of articles that discuss change and process improvement models and frameworks led to the identification of three research streams that this paper will build on, specifically: business process reengineering, business model canvas, and A3 process.

2.1 Process Reengineering

Studies have indicated that companies aim for process reengineering in three situations: (1) companies are facing difficulties and are desperate to find solutions; (2) companies are in a stable situation with satisfactory performance but their management anticipates difficulties, and (3) companies are in peak positions yet their management are ambitious and innovative and seek continuous process improvements [23]. Major process reengineering methodologies have been published in the literature since the early 1990s – most notably the ones presented in Figure 1 [24–31]. As shown in Figure 1, the methodologies can be distributed on four main processing reengineering phases:

- Defining current state
- Analyzing and re-designing the current state
- Developing future state
- Implementing and monitoring the future state

Moreover, research in the AEC industry has also presented AEC-oriented reengineering methodologies. Examples include studies on reengineering construction processes [32], construction management process reengineering [33–35], cross-organization process integration in the design-build team [36], process reengineering and improvement for building precast production [37], a redesign process model for design companies [38], and a lean-based framework to re-engineer processes in the era of Construction 4.0 [39].

Existing Methodologies	*Defining Current State*	*Analyzing and Re-designing Current State*	*Developing the Future State*	*Implementing and Monitoring Future State*
Harrison and Pratt (1993)	**1.** Set direction for reengineering **2.** Baseline and benchmark current process	**3.** Create the vision to proceed forward **4.** Launch problem solving projects	**5.** Design improvements across processes	**6.** Implement change **7.** Embed continuous improvement
Furey (1993)	**1.** Determine customer requirements and goals **2.** Map and measure existing process	**3.** Analyze and modify existing process	**4.** Design a reengineered process	**5.** Implement the reengineered process
Manganelli and Klein (1994)	**1.** Preparation **2.** Identification	**3.** Vision	**4.** Technical and social design	**5.** Transformation
Underdown (1997)	**1.** Develop vision and strategy for reengineering	**2.** Create desired culture to implement reengineering	**3.** Integrate and improve the enterprise	**4.** Develop technology solutions
Mayer and DeWitte (1999)	**1.** Motivating reengineering and starting correctly **2.** Justifying reengineering	**3.** Planning reengineering projects **4.** Setting up for reengineering	**5.** "To-be" design and validation	**6.** Implementation
Adesola and Baines (2005)	**1.** Understand business needs **2.** Understand the process	**3.** Model and analyze process **4.** Redesign process	**5.** Implement new process	**6.** Assess new process and methodology **7.** Review new process
Muthu et al. (2006)	**1.** Prepare for BPR **2.** Map and analyze "as-is" process	**2.** Map and analyze "as-is" process	**3.** Design "to-be" process	**4.** Implement reengineering process **5.** Improve continuously
Tiamaz et al. (2018)	**1.** Define goals **2.** Prepare the environment	**3.** Understand the process	**4.** Manage wastes	**5.** Implement **6.** Revise **7.** Sustain results

Figure 1 Summary of the existing methodologies

2.2 Business Model Canvas

One of the major challenges that organizations face is communication. In fact, businesses can find themselves struggling to "make the unfamiliar familiar" when sharing ideas and plans with different internal and external stakeholders, making it a challenge to "frame ideas in terms, metaphors, or analogies that make them understandable" to all those involved [40]. One way of solving communication problems is business models, which can be used as "analogies for innovating businesses" and framing communication within companies and between them and their investors [40,41].

A business model describes the rationale of how an organization creates, delivers, and captures value [42]. It is an efficient guide that allows businesses to discover value creation, identify customer needs, exploit external opportunities, identify required resources, generate and increase profits, and perform short, medium, and long-term projections [43]. Moreover, clearly-understood business models can support strategic competitiveness by providing organizations with insights into the alignment of high-level strategies and underlying actions in an organization [44,45].

To develop and communicate business models, Osterwalnder and Pigneur [42] proposed the "Business Model Canvas" (BMC). BMC serves as "a blueprint for a strategy to be implemented through organizational structures, processes, and systems", and the canvas includes nine basic building blocks covering the four main areas of a business – customers, offer, infrastructure, and financial viability [42]. Its holistic approach, visual representation, and simplicity The holistic visual and simple approach gained BMC momentum with new business ventures in its early stages, then made its way into incumbent firms with well-defined business models that use BMC to innovate and maintain competitive advantage [46].

BMC also gained momentum in research, as researchers mutate the canvas' building blocks and make them more oriented toward specific industries and transformations [47]. Mutations can include adding, removing, and/or dividing blocks, modifying the blocks' content, linking elements between the blocks, and adding views that reflect the mutated canvas' specific objectives [48]. In the AEC industry, examples of mutated BMC

include the "Business Model Transformation Canvas" (BMTC) which illustrates the construction business model in Industry 4.0 [49], and the "Construction 4.0 Implementation Canvas" (CONiC4.0) that aims to provide implementation practices that can guide AEC organizations towards a successful Construction 4.0 vision [39].

2.3 A3

The A3 tool originally evolved from Toyota Production System where it was traditionally used as a collaborative problem-solving method [50]. It is named after the international paper size of A3 – a single sheet of ISO A3-size paper with SI dimensions of 297 millimeters x 420 millimeters or about 11 inches x 17 inches in the US [51]. At Toyota, A3 became the "standard for telling stories with facts" and "convey information in a single page using bullet points, charts, and graphs" and very few words [22]. The use of A3 evolved from "Problem-solving A3" to using the tool for reporting project statuses work-related proposals, and strategic planning [51].

A3 typically has sections that describe the theme and background, the problem statement or the current condition, the target statement or desired future state, systematic scientific analysis (such as root cause analysis (5 Whys), cost-benefit analysis (CBA), and cause-effect diagrams), possible solutions often involving cross-functional coordination, implementation timeline with actions and responsibilities, the impact of achieved results, follow-up actions with responsibilities and learning points to share [50,51].

With the rise in Lean construction, A3 became a central focus and it was used for different applications such as decision-making [18], simulations and gaming [52], continuous improvement [53], and sharing knowledge and lessons learned among project stakeholders [54].

3 Methodology

The methodology employed to develop the AWP improvement canvas encompasses four tasks. The first task consisted of reviewing existing methods for problem-solving and designing solutions. Existing business process reengineering models were summarized, the business model canvas - the most popular innovative business model - was reviewed, and the A3 process, which emerged at Toyota as part of the Toyota Production System, was examined. The outcome of the first task informed the authors about 1) elements that are crucial for organizations to consider when improving a process and 2) visual methods in which the improvement plan or process can be communicated. The authors then, for the second task, conducted six focus group discussions with seven AWP subject matter experts. The focus group participants were asked to share their experience developing and implementing workflows and processes within their organization to improve their AWP practices. Content analysis was employed to analyze the interview data and proceeded in three steps: initial reading, coding, and creation of themes. A code is a phrase that represents a single idea and a theme is a word or phrase that describes a group of codes. For example, "prioritize solutions and receive buy-in" was coded from the interviews and assigned to the "Solution" theme.

The rich data collected from the interviews and the content analysis led to the identification of six key themes, or building blocks, that the AWP Improvement Canvas (AWPIC) must include when guiding organizations to successfully improve their AWP implementation (third task). These six Once developed, the canvas was discussed and validated with the AWP subject matter experts (fourth task). The canvas is developed to assist with making process and organizational reengineering decisions but most importantly to help organizations align these decisions to the overall transformation objectives.

4 The Proposed AWPIC

The proposed Advanced Work Packaging Improvement Canvas (AWPIC) is illustrated in Figure 1. AWPIC encompasses six building blocks that illustrate the flow and logic of how an organization can move from a current state that needs improvement to a future desired state.

4.1 Building One: Current State

The first building block is the Current State located on the bottom left of the canvas. This building block documents the current state conditions by clearly articulating shortcomings and the areas in need of improvement.

4.2 Building Two: Problem

The second building block is the Problem located above the Current State. This element aims to contextualize the problem by tackling the what, where, who, and when. In formalizing what the problem is, the team is encouraged to consider the following why questions: (1) Why do we believe to have a problem?; (2) Why do we have this problem? (It is recommended to employ the five why analysis to identify the root causes of the problem); and (3) Why do we need to improve?

Answering these three questions creates agreement on the problem, thus ensuring buy-in from all team members. Following the discussion of the problem, the

team must clearly show where in the project lifecycle of the project the identified problem this.

Next, all internal and external stakeholders (individuals, teams, and organizations) that are impacted by the problem, that will be impacted by the solution, and those critical to the improvement process must all be identified. The team then discusses the urgency of the problem and devices a timeline to act (immediate action, intermediate action, and long-term action).

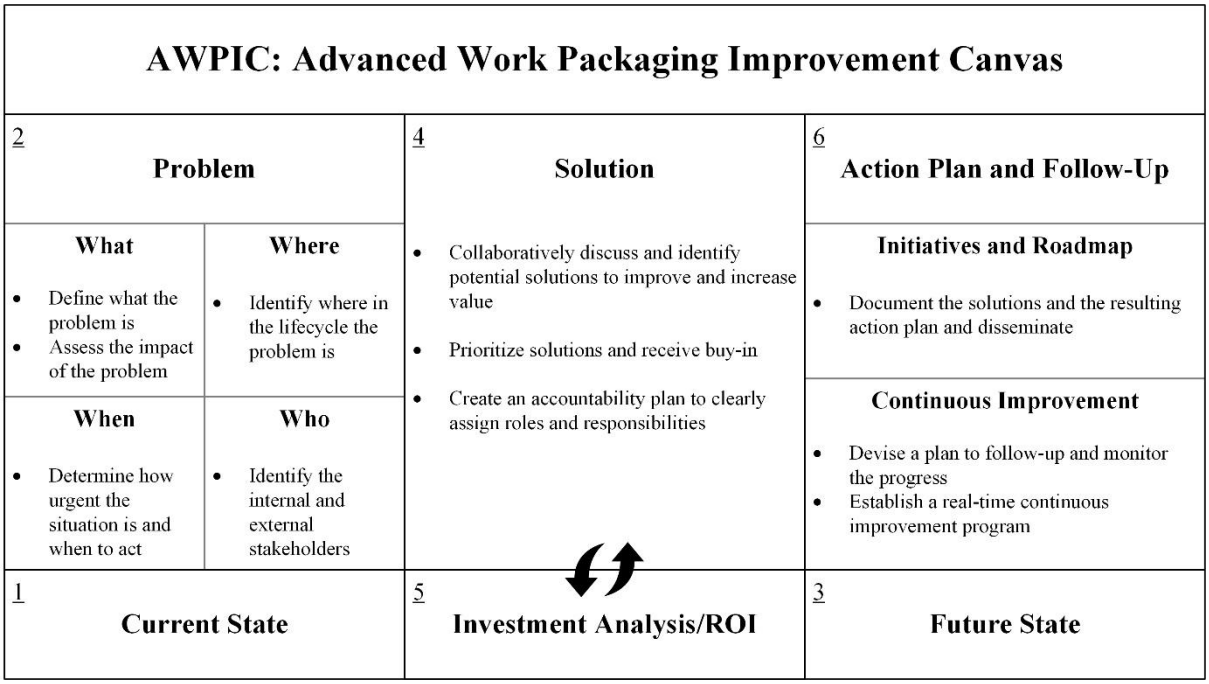

Figure 2 Proposed AWPIC

4.3 Building Three: Future State

Following a thorough understanding of the problem and its implications on the organization, the team then sets the goal for the Future State, i.e., the third building block located on the bottom right corner of the canvas. It is important to note that the Future State block must be continuously referenced and evaluated throughout the improvement process to ensure that the discussions align with the desired objectives.

4.4 Building Four: Solution

The fourth building block is the Solution located in the middle of the Canvas. The team works collaboratively to brainstorm and develop potential, realistic solutions that could be implemented to address the problem and help the organization move from its current state to its desired future state. After expanding the range of possible solutions, the team should define criteria for reducing the number of ideas to a manageable few. The criteria should be specific to the context of the business of the organization but could include factors such as estimation implementation timeline, possible resistance, and impact on competitive advantage. Moreover, the team must discuss an accountability plan that clearly assigns roles and responsibilities to selected stakeholders to ensure.

4.5 Building Five: Investment and Value Creation Analysis

Simultaneously with Solution, Investment and Value Creation Analysis (the fifth building block) must be also considered because available resources and revenue potential are critical criteria that impact the feasibility of potential solutions. There is a loop connecting the Solution and Investment and Value Creation Analysis building blocks because these two are connected and one influences the other.

4.6 Building Six: Action Plan and Follow-Up

The sixth and last building block is the Action Plan and Follow-Up located to the far right of the canvas and above the Future State. This building block aims to document the solution resulting from the back-and-forth considerations of the fourth and fifth building blocks. An action plan with the proposed solutions, responsible parties, the expected timeline, expected outcomes, and

anticipated challenges must be developed to clearly communicate the initiative and the change roadmap to all involved parties. Zone management can be implemented to structure the action plan [55]. Zone management is a discipline that provides organizations with a strategic plan to allocate resources across three investment horizons: horizon 1 (in the coming fiscal year), horizon 2 (in two to three years), and horizon 3 (in three to five years). In addition to the timeline, zone management differentiates between disruptive and sustaining innovation and revenue performance versus enabling investment. Moreover, to ensure the effectiveness of the plan and create a mechanism for continuous improvement, a follow-up plan must be integrated into the last building block. The team can for instance specify when the team must revisit the plan to evaluate if the set desired future state has been achieved or not.

5 Conclusions, Limitations, and Future Work

Decisions in today's environment will have more consequences on project outcomes. The demand for making the best decisions will be crucial. They need to be earlier, more informed, have visual evidence, leverage enabling tools, and be deeply aligned across stakeholders. They will need to be based on leading indicators to affect work before execution versus lagging indicators that react to events in the past (proactive versus reactive).

This paper presented a proposed Advanced Work Packaging Improvement Canvas (AWPIC) to assist organizations in improving their current AWP practices through a structured decision-making roadmap. AWPIC is the culmination of data collected from seven AWP subject matter experts regarding their experience with AWP improvement and change efforts. AWPIC consists of six building blocks: *Current State*, *Problem*, *Future State*, *Solution*, *Investment and Value Creation Analysis*, and *Action Plan and Follow-Up*. While this paper proposed a new canvas to improve AWP implementation, it has its limitations. The proposed framework is a concept, and its practicability has not been tested yet. Additionally, the authors are expanding on the interconnectivity between people, processes, technology, and culture for each block. The canvas will further progress by conducting a series of case studies with small, medium, and large organizations to understand AWPIC in action and study the effectiveness of the proposed building blocks. Through a longitudinal study, the authors will work with various construction organizations and will use the canvas to guide change efforts.

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