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AWP METHODOLOGY: LITERATURE REVIEW AND INTEGRATION WITH BIM

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Abstract: AWP (Advanced Work Packaging) is a project management methodology that focuses on the physical division of the work and the planning of the construction sequence by installation, engineering and supply packages. The methodology was created in 2009 and aims to increase the predictability and productivity of the project. This article brings together the main information and challenges about AWP published since its conception and describes how the methodology can integrate and enhance the use of BIM 4D in construction planning and execution. The research method adopted was a structured literature review. At the end of the information gathering, an analysis was made of the application of the methodology integrating it with BIM, more specifically its use in planning. As a result, it is clear that the AWP methodology scenario still lacks information to prove the benefits of its application. This article contributes to organizing information on AWP and to reflecting on its benefits as a project management methodology, especially when integrated with BIM.
Keywords: AWP. BIM 4D. Planning. Construction.

INTRODUCTION

The construction industry involves a wide range of high-cost activities, so construction processes are often lengthy and involve a series of stages, from the conception of the project to its execution. During these stages, the expectation of optimizing the project and reducing costs diminishes, since as the project progresses, decisions are made based on more detailed and less flexible information.

Between 1995 and 2018, construction contributed to a 0.62% drop in aggregate productivity in Brazilian industry [1]. Given this scenario, the application of methods capable of providing greater control over predictability is of great value and can promote the execution of projects previously considered financially unfeasible.

BIM (Building Information Modeling) and AWP (Advanced Work Packaging) are processes that enable the modeling and management of construction project information through the gathering and handling of data, providing an integrated view of the project and ensuring conditions for more accurate decision-making.

Studies show that the use of AWP in projects has resulted in significant productivity gains, cost reductions and even a reduction in the number of accidents at work [2]. In view of this, this article addresses issues related to enabling more efficient and collaborative management by integrating BIM with AWP.

Finally, the article aims to bring together the most relevant information on the subject of integrating the AWP methodology with BIM and to map the state of the art of the subject, such as the main contributions, trends and knowledge gaps in relation to the efficiency and effectiveness of the methodology and the advantages of its development for the construction sector.

METHOD

The methodology used was a structured literature review, which analyzed works whose theme was related to the use of the AWP methodology and, where possible, simultaneously with BIM.

The review was conducted by means of a systematic search in the Scopus database and directly in the consultation materials offered by AWP University and the CII. Since there are still not many works on the subject, the only keywords used in the search were the sets "AWP AND Methodology" or "AWP AND BIM", which generated a total of 07 results within the "engineering" category with works in English from the last five years (from 2019 to 2024).

In order to have a wider range of sources, the same keywords and filters were submitted to a search on Google Scholar and, on this basis, the results returned a total of 153 articles.

It is worth noting that this database does not allow the results to be filtered by the 'engineering' category. Therefore, articles related to the construction sector within the first 50 results were analyzed.

RESULTS

CONCEPT AND HISTORY

The concept of AWP originated in the 1990s, when the Construction Owners Association (COA) and the CII decided to tackle low productivity in the construction industry. They began by assigning colors to 3D models to indicate the status of buildings and then incorporated time-related information using the 4D model concept [3].

In the early years of the 21st century, the first software capable of working with the PWA methodology appeared. This period also saw the establishment of the annual PWA conference, with the aim of deepening the study of the methodology and acquiring material to prove its effectiveness. However, it wasn't until 2011 that PWA was truly consolidated, when the revision of RT272 (Research Team) was launched, which consisted of the first standard of good practice related to PWA. Figure 1 shows a timeline of the evolution of studies on the methodology [3].

DEFINITION

AWP is a project planning and execution methodology whose fundamental application consists of creating detailed work packages ready for execution [2]. The IIC classifies AWP as a stage in the process of improving project productivity and predictability which, together with work on an EPC (Engineering, Procurement and Construction) project, establishes initial planning and then detailed design for construction execution.

STRUCTURING

The PWA structure is divided into four main phases [2], explained below:

1. Overview

In the overview phase, the project is defined and its objectives are established. At this stage, it is important to define the scope of the project, identify the stakeholders, their requirements and expectations, as well as assess the risks and challenges.

2. Planning

The planning phase consists of detailing the project and setting up the work packages in order to facilitate their application and execution.

The project's work packages are divided into CWAs (Construction Work Areas), which consist of strategically divided macro areas.

Then, observing the physical limits of the CWAs, the CWPs (Construction Work Packages) are organized by disciplines. The content needed to complete these work packages must be feasible within 3 months and cover quality requirements, project safety standards, planning information and budget. The structuring of the CWPs is interlinked with and crucial to the creation of the PWPs (Procurement Work Packaging) and EWPs (Engineering Work Package), and these work packages must contain the detailed procurement and engineering work packages.

The requirements of the project, including the objectives of the work, the expected results and the delivery deadlines must be clearly defined in the EWPs. These attributes should be organized through an analysis of stakeholder needs and an understanding of the project.

Finally, observing the physical limits of the CWPs, the IWPs (Installation Work Package) are divided. IWPs present instructions with a detailed scope and the possibility of execution in up to 2 weeks.

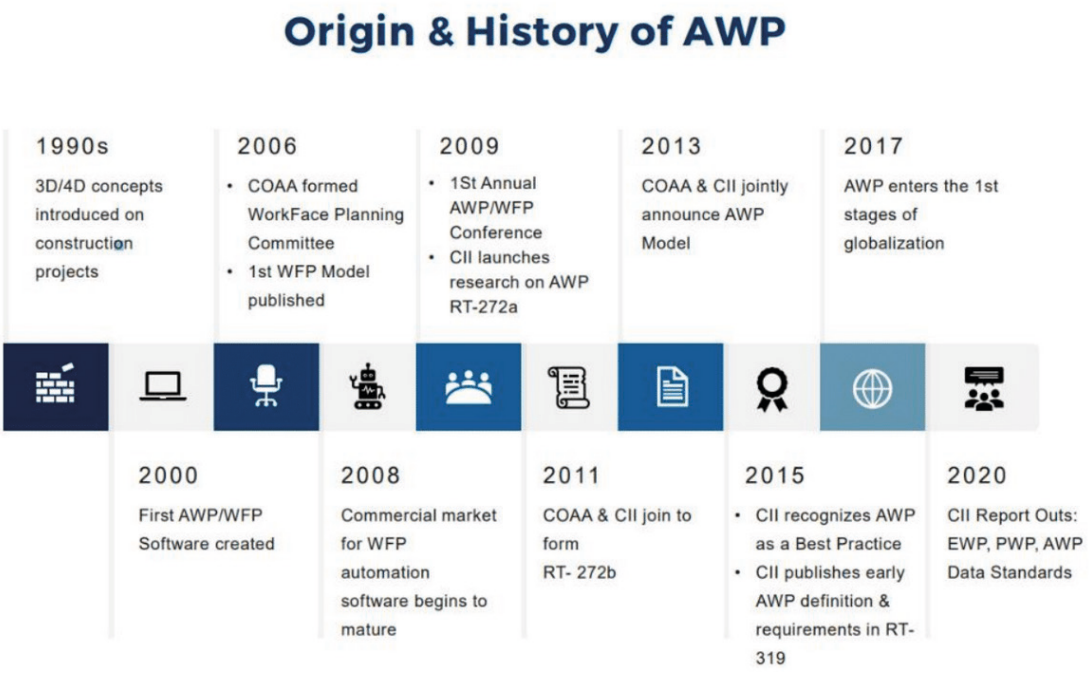

Figure 1: AWP timeline.
Source: [2]

3. Execution

In this executive phase of the AWPs, the work packages are executed and the monitoring of their progress should be carried out periodically and, if necessary, adjustments can be made.

4. Closing

This includes completing the project and evaluating its results. At this stage, it is important to document lessons learned and good practices so that they can be applied to future projects.

IMPLEMENTATION GUIDELINES

The AWP methodology can be applied to projects of different scales, since it has no particularities for large, complex projects [4]. However, the division of works into packages must follow certain guidelines, including execution time, scope, physical size of the space and number of CWAs [5]. Thus, AWP stands out from conventional methodologies in larger projects, since the physical division of works can be more exploited where there is complexity.

In addition, since AWP can be deployed at various stages of the project, it can also be used by specialized engineering services companies.

The benefits of implementation revolve mainly around the maturing of the internal organization of projects, increased predictability, improved quality of deliveries, productivity gains and cost reductions [4]

In order to sequence the construction correctly, four steps are suggested for the "path of construction" [6]. These are: commitment, preparation, collaboration and communication. According to the author, the path of construction explains how the project will be sequenced in the field and how the Engineering and Procurement deliveries should work.

By analyzing the stages and interdependencies, with the implementation of AWP, the stakeholders must be well aligned and the schedule of the Procurement and Engineering team must be pulled along by the construction schedule [7]. In addition, the author discusses the possibility of using ERP (Enterprise Resource Planning) software to help with this planning.

The application of the AWP methodology can generate extra initial costs for projects, but there is no clear method for calculating these costs. However, it is possible to assess the level of maturity of the methodology implemented in the company through the financial costs due to its implementation, the work fronts plan, the characterization of teams and supervisors, external problems and performance measurement metrics [8].

When it comes to implementing cost management systems, it is known that this changes the organization's working philosophy and thus directly impacts employees, products and processes, generating effects throughout the organization. The 7Cs model, for example, was developed with a view to implementations that generate team commitment to continuous improvement [9]. This model was created before the PWA methodology was formalized, but it is possible to see it being used to help implement PWA. This model is briefly based on the following principles:

- Culture - Focus on long-term performance;
- Champion - Fully trained professional dedicated to the job;
- Change Process - Resource planning, measures against resistance; timetable and change strategy;
- Commitment - Promoting the evolution of the group;
- Controls - Monitoring the progress of implementation;
- Compensation - Rewards program for engagement;
- Continuous Education - Constant periodic training.

IMPLEMENTATION CHALLENGES AND POSSIBLE SOLUTIONS

With the aim of analyzing the biggest challenges faced by companies when implementing the PWA, a survey was carried out with 36 companies and 78 challenges to the full implementation of the PWA were identified [4]. The challenges were ranked by the respondents and, to facilitate understanding, the research team divided them into 4 categories, along with the main challenges included in each one (Chart 1).

After dividing them into four categories, the same research group organized the main challenges in terms of their appearance in companies with different levels of PWA maturity. This division was based on the ranking previously made by the respondents.

It was observed that companies with a more mature AWP in place had more challenges to overcome when it came to relationships with external suppliers who were not as mature, while companies with a less mature AWP still had problems convincing the team of the benefits of the methodology.

Subsequently, a new study sought out relevant professionals from 10 large companies and prepared another survey in order to identify possible solutions to the challenges identified in the previous work [10]. Potential solutions were listed and the details of implementing each one were explained. For a better representation, the study grouped them into relevant themes and distributed them according to their possible application according to the phase of the project. It is possible to identify the phases of the project it considered in its work and the number of solutions developed respectively (Table 2).

Category	Challenges
PWA maturity level implemented	Low level of AWP implemented in contractors
	Little standardized training in the companies
	Contractor does not demand contracts in AWP
	Culture of not changing existing processes
Integration between AWP and the engineering team	Suppliers of projects lacking AWP culture
	Engineering projects do not comply with construction sequence
	Inability to trace the Path of Construction (PoC)
	Integration between AWP and existing processes and general systems
Integration between AWP and existing processes and general systems	Lack of general alignment between office and field
	Problems convincing people of the benefits of PWA
Problems convincing people of the benefits of PWA	Lack of information and training on the benefits of AWP
	Companies awaiting publication of project results

Chart 1: Categories and challenges of PWA implementation

Source: Adapted from [4]

Background	Implementation				
Pre-implantation	Planning	Project	**Supplies**	**Construction**	**Commissioning**
Adherence to methodology (9 solutions)	Implementation plan (9 solutions)	Engagement (2 solutions)	Engagement (1 solution)	Engagement (1 solution)	Engagement (3 solutions)
AWP Education (8 solutions)	Contracting (12 solutions)	Resources (4 solutions)	Resources (3 solutions)	Resources (4 solutions)	Resources (3 solutions)
Organizational alignment (6 solutions)	Resources (6 solutions)	Attribute model (3 solutions)	Technology solutions (1 solution)	Deliverables (2 solutions)	Deliverables (1 solutions)
Contract integration (8 solutions)	Construction Path (2 solutions)	Customer requirements (2 solutions)	Deliverables (5 solutions)	Material control (17 solutions)	
Scalability (2 solutions)	Alignment (10 solutions)	Deliverables (3 solutions)		Interference resolution (4 solutions)	
Resistance (3 solutions)		Construction sequence (6 solutions)		Change management (8 solutions)	
		Construction division (15 solutions)			
		Building Control (4 solutions)			

Chart 2: Possible solutions to challenges encountered in implementing PWAs, by project phase

Source: Adapted from [10]. Free translation.

AWP CASE STUDY

A case study in Finland analyzed the implementation of PWA in a pilot project by the company CITEC to meet the demands of its construction partner Wartsila. The focus of the pilot was to achieve predictability gains during all stages of the project [5].

To develop the pilot, interviews were held with 7 professionals who took part in the pilot project, 6 from CITEC and 1 from Wartsila. The professionals from the first company had responsibilities that had a direct impact on the progress of the project. The professional from Wartsila was appointed AWP Champion and was responsible for keeping the mentality of implementing the methodology active [5].

In summary, the interviews showed that the professionals recognized the advantages of implementing the AWP compared to the previous management methodology. In addition, they mentioned that CITEC's old way of working, based on the "Gate Model" (delivery in phases) methodology, does not create major impasses, even with the change to the engineering delivery packages (EWPs) based on the physical division of the work (CWAs). However, even with the availability of the Wartsila professional as a disseminator of the AWP culture, the CITEC professionals mentioned the need for some extra time to adapt to the new working methodology. In addition, some employees found the methodology inconvenient, given that it prioritizes more complex conflicts [5].

Finally, it was reported by the electrical project team that, given that the system has the characteristic of being distributed throughout the plant, it would be difficult to make modular deliveries rather than a single one. It was also mentioned that it would just be a question of alignment on how to proceed [5].

BIM MODELING (BUILDING INFORMATION MODELING) 4D

Not just limited to the geometry of the building, the BIM methodology aims to assign information to the model that generates support in the phases of project management, planning, execution, operation and other activities linked to the work [11]. By definition, BIM is a collaborative decision-making platform to facilitate the sharing of information based on project management models and simulations [12]. There are currently several definitions available for BIM, but all of them consistently emphasize the importance of process integration as a fundamental element for the success of a project that adopts this methodological approach.

4D BIM modeling can be defined as the integration of 3D models with the time dimension [13]. This integration results in schedules that better reflect the construction sequence of the work and thus greater control of deadlines [14]. These improvements are made possible by the integration of the spatial and temporal dimensions, which are facilitated by the visualization in 3D models and the simulation of the sequence of construction activities. This results in more reliable schedules and significantly improves communication management on the project. Using BIM models, it is possible to assign CWA's and CWP's and identify these areas in the model to simplify the association of documents, materials, quality requirements, safety measures and other relevant elements [13].

4D modeling can be done using CAD and BIM models and, with the use of BIM technology, refers to the use of analysis tools that incorporate BIM components and information related to the construction method to optimize the sequencing of activities. These tools take into account available space, resource allocation and productivity data [11]. With this, the use of 4D BIM modeling can help vi-

sualize the spatial arrangement of objects on the construction site throughout the evolution of the project, in order to represent their allocation in a specific time frame, resulting in significant improvements in the physical use of space [15].

The discussion on the "Integration of Methodologies and Tools" in the AWP highlights a significant area for future research and development. Challenges include the need to adjust existing operational logic and integrate Workface Planning with BIM/AWP. These complexities highlight the importance of developing more cohesive systems and interoperable methodologies and tools that can be seamlessly integrated into current project management frameworks [16][17][18]. Future research should focus on creating and improving tools that facilitate the integration of PWA with other established methodologies, such as Lean Construction and BIM. This involves not only technological innovation, but also an understanding of how these methodologies can complement each other to improve the efficiency and effectiveness of projects.

CONCLUSION

AWP creates detailed work packages ready for execution, providing more efficient planning, reducing costs and increasing productivity [19].

BIM, on the other hand, offers a complete digital representation of the project, allowing for 4D modeling, which integrates the time dimension into the 3D model and creates the necessary conditions for more precise planning, with simulations of the sequencing of activities, helping to guarantee compliance with deadlines and optimizing the use of spaces on the construction site.

The combination of AWP and BIM can lead to numerous benefits, such as the association of CWAs and CWPs in the model, organizing the management of information and documentation and ensuring that all the elements needed to carry out the work packages are available and aligned with the project's needs.

However, there are still challenges that need to be overcome. Obtaining quantitative validation in projects that do not incorporate BIM or AWP is one such obstacle. Although there is evidence to support the benefits of these methodologies, it is necessary to seek validation in different contexts to ensure their effectiveness. In addition, most of the resources and information available are offered by institutes that promote the dissemination and implementation of these approaches, and they often require payment for access. Thus, this can represent an obstacle for companies and professionals interested in adopting such practices. Although there are case reports of successful applications of these methodologies, only a few of them have quantitative information available. This scarcity makes it more challenging for stakeholders to assess the benefits based on concrete results.

Finally, integrating BIM with AWP remains a valuable approach to managing construction projects. As the sector evolves, it is important that efforts are made to overcome these impasses and provide wider access to quantitative information that demonstrates the tangible benefits of these practices. This integrated approach is key to meeting the growing demand for more efficient processes, contributing to the success of projects previously considered too complex due to financial issues.

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