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Project management: hybrid approach for construction projects

Abstract

This research aims to innovate in project management by demonstrating the benefits of implementing the Hybrid ProjectManagement Methodology in construction projects. The construction industry operates in complex environments with high levels of change, making it essential to adapt management approaches accordingly. This study reveals that integrating Agile with Traditional Project Management Methodology enhances project execution by fostering flexibility, adaptation, continuous value delivery, motivation, effective Methods communications, and constant feedback throughout the project life cycle. Consequently, this integration leads to improved project outcomes and goal achievement. Furthermore, the research highlights the growing recognition among construction professionals of the importance of adopting methodologies that enhance their project management skills, demonstrating a pressing need for such approaches in the industry. Statistical validation confirms the appropriateness of applying the Hybrid Project Management Methodology in the construction sector, with a significant result of 3.903, indicating a high level of appropriateness.

Keywords: hybrid approach, agile methods, construction projects, delphi technique, hybrid methodology, project management, traditional methodology, agile, construction industry, construction project management.

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Yaiseth Frangakis Cano
Universidad Internacional Iberoamericana. Doctorado en Proyectos – UNINI- MX, Panama

Correspondence: Yaiseth Frangakis Cano, Universidad Internacional Iberoamericana. Doctorado en Proyectos – UNINI- MX, Panama,
Email yaiseth.frangaki@doctorado.unini.edu.mx

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Introduction

The construction industry is emerging as one of the most influential global drivers of worldwideeconomic growth. According to the report "Futureof Construction: A Global Forecast for Constructionto 2030" by Marsh and Guy Carpenter (2021), significant growth is projected in different regionsby 2030. Growth is anticipated to be 50% in Asia-Pacific, 32% in North America, 23% in Western Europe, 35% in Latin America and 42% globally. However, the current environment in which construction projects are developed is increasinglycomplex and challenging. Unexpected situations arise that put project management to the test, which can affect project results. In addition, the industry is facing significant changes, such as environmental, social and governance (ESG)considerations, the adoption of new construction methods and the emergence of the deconstructionindustry. Lack of project management expertise among professionals and failure to meet targets are additional challenges that contribute to the changing risk profile of the industry. To address these challenges, it is crucial to adopt a mindset oriented towards innovation andcontinuous improvement in project management. Constantly updating project management methodology, along with implementing more efficient practices, can lead to resource and cost savings while ensuring quality and on-time delivery. This, in turn, increases the chances of project success and customer satisfaction, as wellas profit margins for companies.

It is essential to improve the skills of construction professionals and foster a mindset of continuing professional education and development. Major problems identified in the construction industry include missed deadlines, increased costs, customer dissatisfaction, and poor quality. These challenges can be attributed to inefficient problem solving, lack of timely risk detection, inability to correct failures, resistance to change, and lack of client involvement in the project.

This research was developed in Panama, where since 2003 the profession of project management has been developing, disseminating, and promoting knowledge. However, there is still no guidance focused on improving the skills of professionals dedicated to construction today, which faces significant challenges and changes.

Literature review

For the elaboration of this research, specific criteriawere used in the search for information. These criteria focused on timeliness, contextualization, and relevance of the content. The process consisted of collecting and organizing bibliographically articles from specialized journals, books, statistical databases, regulations, and standards in force in the field of project management. The selection of the information was based on epistemological criteria and the level of representativeness. The logical structure of the material, the most relevant aspects of the content and the contributions of prominent authors on thesubject were assessed. In addition, a review of the ISO 21500 Standard and the fundamentals of agile methods was carried out to develop a Hybrid Methodology that combines the TraditionalMethodology with agile techniques for greater flexibility and adaptation to the specificcharacteristics of each project. Practical project management techniques and tools were analyzed, evaluating their correspondence with the processes established in ISO 21500 and their potential integration with agile methodologies. To collect relevant data on the real problems faced by project management in construction, questionnaires were used as a field data collection method. The information collected was subjected to statistical analysis using SPSS Statistics.

A. Global context of the problem

According to the PMBOK Guide (2021), project management is defined as the application of knowledge, skills, tools, and techniques to project activities to meet project requirements. However, despite the systematic use of these tools and techniques, the success rate of projects remains limited. Previous research reveals that, out of every 100 projects, only about 17% are considered successful. Although this figure has improved compared to previous decades, there is still considerable room for improvement. The creation of organizations dedicated to the development and promotion of project management,

such as the Project Management Institute, has contributed significantly to the standardization of practices and processes in this field. The evolution of project management gave rise tothe Agile Manifesto in 2001, in response to the need to address the uncertainty, complexity and constant changes in projects, especially in the field of software development. Agile methodology allows greater adaptability to project conditions and a more collaborative approach between teams. Today, there is a more flexible perspective on traditional and agile approaches to project management. Experts recognize the importance oftailoring the approach to the specific needs of theproject, combining elements of both approaches as appropriate. This view has led to the emergence ofthe Hybrid Methodology, which seeks to integratethe best of both worlds to address today's challenges in the construction industry. Construction professionals face several challenges, including resource and schedule optimization, globalization, technological revolution, environmental and social responsibility,among others. In this context, agile's[1] practical guide suggests that there is no single approach to hybrid project management, but thatdifferent approaches can be combined according to the specific needs and characteristics of each project. The selection of the most appropriate approach will depend on the particularities of eachsituation, recognizing that each project is unique in its nature and requirements.

B. National context of project management

In Panama, the construction sector began its growth in the late 1990s, expanding by more than 30%, becoming the second most dynamic activity in the Panamanian economy according to reports from the Panamanian Chamber of Construction, based on data obtained from the General Comptroller of the Republic of Panama. It is one of the country's most important economic pillars, contributing approximately 20% of the gross domestic product. This momentum is due to the execution of complex megaprojects in changing environments impacted by competitiveness, globalization, technological changes, new government regulations, environmental standards, and increasingly demanding client requirements.

In Panama, the profession of project management is being developed, disseminating and promoting knowledge through the Project Management Book of Knowledge (PMBOK) Guide, to increase and improve the performance, skills, and professional work of project managers and achieve successful constructions. Despite all the effort made in Panama since 2003, when the Panama Chapter of the Project Management Institute was created, which promotes the knowledge of project managers, updates advances and their global evolution, there is still much development and awareness needed among engineering professionals who manage constructions regarding administration, management, resource management, productive transformation, competitiveness enhancement, technological development, and innovation to achieve satisfactory results in projects.

Methodology

Research design

In this research, an inductive approach was used based on international norms and standards recognized as valid guidelines by the scientific community for project management. Following C Collado et al.,[2] this study isclassified as descriptive, since it identifies and describes characteristics to generate newknowledge. Data were collected and relationships between variables were explored. The research design combined quantitative and qualitative data, following the mixed approach proposed by A Tashakkori et al.[3]The quantitative method was used for the collection and analysis of numerical data, while thequalitative method allowed for deeper study and detailed observations to complement the quantitative data. This mixed approach allows converting qualitativedata into quantitative data and vice versa, according to D Mertens[4]. From an operational perspective, the research design was non-experimental, focused on studying reality in its natural dynamics to describe, explain, and predict it. Regarding the temporal dimension of the research and the number of moments in time when data were collected, the research design modality was cross-sectional correlational, according to C Collado et al.[2] This allowed for analyzing the level of one or several variables at a given moment or the relationship between a set of variables at a point in time, providing information on reality at a specific moment encompassing various indicators.

Hypothesis

The hypotheses validated in this research were:

H1: The application of a Hybrid Project Management Methodology, which combines traditional and agile approaches, helps to achieve organizational objectives, and improve business maturity.

H2: The application of a Hybrid Project Management Methodology, based on the characteristics of the project, improves the results of the project.

H0: There is no significant difference in the achievement of organizational objectives, business maturity and final project results between an organization that uses a Hybrid Project Management Methodology and one that does not.

Sampling and Sample Subjects

The subjects of the sample in this research were chosen because they had essential characteristics for the investigation. The sampling technique applied is called intentional non-probabilistic sampling. The criteria for selecting the subjects of the sample were as follows:

- Be a construction or project management professional.
- Manage construction projects or be related to thesector.
- To have studies in project management.
- Have five years or more of project experience.
- Knowledge of traditional, agile or hybrid methods for project management.

The sample size was determined using the formulaof Spiegel M et al.[5] The target population consisted of 158 professionals from the College of Civil Engineers of Panama and 136 professionals from the Project Management Institute Panama chapter, totaling 294 professionals who met the criteria established for sample selection. Next, equation (1) was used to obtain the ideal sample size. The parameters established for its determination were as follows: a confidence level of 95%, with a proportion of 50% (since this population is not characterized) and a maximum allowable error of 5%.

$$n = \frac{N\frac{Z^2}{e^2}.p.q}{N + \frac{Z^2}{e^2}} \quad (1)$$

Where:

n = Sample size.

N = Population size (294 Construction Professionals).

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p and q = Complementary proportions that can take any value between 0 and 1.

P = 0.5

Q = 0.5

Z = Confidence level of 95%. Constant value 1.96

e = Standard error or sampling error 5%

According to the calculations obtained and the established selection criteria, the ideal sample size for the research was 62 construction project management professionals.

The questionnaire was administered to 86 project management professionals, and upon statistical analysis using the SPSS program, 72 questionnaires were deemed valid, while 14 were excluded due to being incomplete or containing errors.

The calculation for the ideal sample size obtained using the formula by Spiegel M. and Stephens L. (n = 62) was fulfilled, where the actual sample used in the research was n = 72.

Data collection instrument

The data collection instrument for this research was a questionnaire administered to construction and project management professionals. A total of 72 valid questionnaires were obtained, providing the data and foundational information for the development of the hybrid methodology applied to the construction industry. The questionnaire was composed of 42 items belonging to 9 dimensions related to the various aspects under investigation. Closed-ended questions were used to gather data related to participants' personal domain and professional behavior, their experience, and their current knowledge of project management methodology. To collect information about opinions, level of information, and expectations regarding project management, a Likert scale was employed. In this scale, professionals rated each item on the questionnaire by assigning a score on a three-point scale: low (1), medium (3), and high (5). The obtained foundational information was as follows: the level of compliance with the project's main constraints using the current project management methodology, aspects of the project management methodology that can be improved, the influence of external factors on the project management methodology affecting project execution, the impact of project failures on companies, aspects for improving the currently used project management methodology, expectations for an ideal project management methodology, and the most important applications when executing a construction project.

Research variables

The independent variables are explanatory, whose association or influence on the dependent variable is intended to be discovered in the research. The independent variables used in the data collection for this research were: gender, educational level, industry, use of project management methodology, type of project management methodology used, most applied project management method, project management governance, tools, techniques, or templates of agile methods that could complement the process groups of traditional methods. According to the research results, it was determined that the independent variables: educational level, use of project management methodology, type of project management methodology used, most applied project management method, project management governance, tools, techniques, or templates of agile methods that can complement the process groups of traditional methods, have an influence on the dependent variables. And their relationship is directly proportional; the better the project management methodology is applied, the better the results obtained at the end of the project execution.

The dependent variables are those that can hypothetically be influenced by an independent variable; therefore, the behavior of the former depends on the latter. The dependent variables used were: project outcomes obtained with the application of some project management methodology, tools, or techniques.

Statistical criteria for data analysis

The data collected from the research questionnaires were subjected to statistical analysis using the SPSS program. This made it possible to evaluate the reliability and validity of the questionnaire, as well as to generate a matrixof data and variables, analyze the results and create graphical representations.

The reliability of the questionnaire was assessed using two main criteria:

- Discrimination Index: This index indicates to whatextent each item contributes to the internal consistency of the questionnaire. It was determined by the corrected total item correlation. Items with a discrimination index in the range of 0.10 to 0.19 were eliminated, since they are at thelimit according to A Pantoja[6].
- Cronbach's alpha coefficient: This was used as a measure of the internal consistency of the questionnaire. This coefficient varies between 0 and 1, being considered acceptable when it is equal to or higher than 0.70.

Cronbach's Alpha coefficient for the questionnaireof this research was 0.815, calculated for the 20 variables with discrimination indices greater than 0.2. To assess construct validity, the following criteria were used: Kaiser-Mayer-Olkin Index (KMO): This index varies between 0 and 1, where a value of less than 0.5 indicates that the correlation between the variables is not sufficiently significant (Table 1 & 2).

Table 1 Reliability of the research questionnaire

Cronbach 's alpha	Cronbach's alpha based on standardized items	N° of elements
0.806	0.815	20

Table 2 Construct validity of the research questionnaire

Kaiser-Meyer-Olkin measure of sampling adequacy.	0.693
Barlett's test for sphericity	0

Barlett's test of sphericity: This test contrasts the null hypothesis that the variables are not correlated. Construct validity is considered adequate if the significance level of this test is less than 0.05. The results of the statistical analyses show that thereliability and validity criteria of the research questionnaire are met: The internal consistency of the questionnaire is good, since all the variables have a discrimination index greater than 0.2. The reliability of the questionnaire is acceptable, with a Cronbach's Alpha coefficient of 0.815, which exceeds the 0.70 threshold. The construct validity is adequate, with a KMO index of 0.693 and a Barlett's test of sphericity witha value of 0.000, indicating a significant correlation between the variables. Based on the fulfillment of these statistical criteria, we proceeded with the factor analysis of the research questionnaire to group the related variables.

Discussion and results

Based on the results obtained from the research questionnaire, a hybrid project management methodology was developed for the

construction sector, validated by national and international experts. The following information was gathered from the statistical analysis: The most widely used project management methodology in the construction sector, is the traditional methodology, used by 63.41% of the construction professionals, the best-known standards being those of the PMI (Project Management Institute). 26.6% of construction professionals have some knowledge or have heard of the hybrid methodology. Of this percentage, only 8.6% have applied it to construction. The best-known agile methods in the construction industry are: Kanban, Lean and Scrum. The results of the research questionnaire proved that there are external factors (independent variables) to the project management methodology (dependent variable), which directly influence its results. The most important independent variables are: Skilled, experienced, integrated, collaborative, motivated work team with good leadership.[7–18]

Knowledge and correct use of programs, platforms, tools, and technologies.

Clear objectives and good communication.

Constant monitoring, control, and feedback during project execution.

It was statistically proven that the influence of these variables or factors is directly proportional tothe results of the project management methodology; the higher the positive contributionof these variables, the greater the benefits obtained from the application of the project management methodology. A statistical analysis of the influence of the management methodology (independent variable)on compliance with the main constraints of the project (dependent variables) showed that theexecution time was not met in 63.41% of the projects, followed by non-compliance with thebudget in 15.85% and 10.98% of non-compliancewith customer satisfaction.

The results obtained from the information provided by the construction professionals proved that an efficient project management methodology should consider integrating all project factors and increasing the agility of execution of complicated processes, reducing rigid methods and highly structured techniques that produce high consumption of time and resources. According to the statistical analysis of these variables and according to the Likert scale used, the level of improvements required in the application of the traditional methodology in terms of the aboveaspects is medium to high. Based on all the above results, the hybrid methodology for the construction sector was developed: Emphasis was placed on techniques and methods that will help obtain favorable results with respect to time, budget, and customer satisfaction constraints. The external factors affecting project management were integrated regardless of the management methodology used. The characteristics that, according to construction professionals, an efficient project management methodology for the sector should have been also considered.[19–27]

Development of the hybrid construction project management approach

The hybrid management methodology for construction projects developed in this research uses a traditional approach throughout the entire project life cycle, simultaneously combined with an agile approach applied to the process groups recommended by the ISO 21500:2012 Project Management Standard; as shown in Figure 1. It is important to remember that each project is unique by nature and the adaptation of the hybrid methodology to be used must be done considering its specific characteristics and constraints: scope, schedule, cost, resources, quality, and risks, wherethe importance of each one changes with theobjectives of each project. Consideration should also be given to the project environment, organizational culture, stakeholder needs and governance. The Figure 2 presents the uncertainty and complexity model to determine the most appropriate approach for the project. The agile methods used as a complement to the traditional methodology, analyzed in this researchwere selected according to the following criteria: More holistic agile frameworks, oriented to a broadset of project activities. Common use in a variety of contexts. Popularity of application adopted by various industries. Characteristics applicable to the construction industry and the results of the research questionnaire. Based on the above criteria, the agile methods selected were Scrum, Kanban, Lean Construction,Scrumban, Feature Driven Development and the Dynamic Systems Development Method. According to the analysis and validation of the hybrid methodology, the agile methods compatible with the characteristics and requirements of the construction sector that complement the traditional methodology are: Scrumban and Lean Construction.

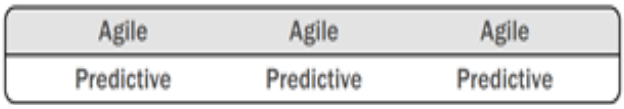

Figure 1 Hybrid approach combining agile and traditional methodologies simultaneously throughout theproject life cycle.

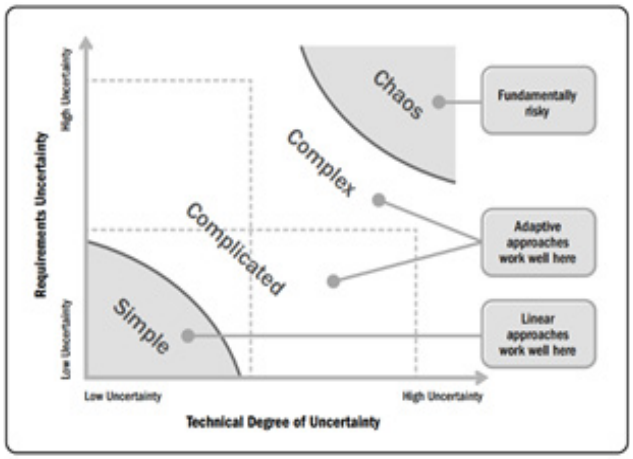

Figure 2 Uncertainty and complexity modelSource: Practical Guide to agile.

Lean Construction: Maximizes results while minimizing delays generated by delays and waste in the use of resources to meet objectives. Its most common obstacles are lack of clarity in the definition of the scope and objectives of the project, excessive time spent in meetings, and excessive time spent in meetings. unnecessary, misuse of resources: people, time, and money. It is based on efficiency and flow of results, efficient meetings, achieving committed teams, risk management, reserve planning, application of standardized processes, prioritization of projects and quality of life of the team.

Scrumban: Transition between Scrum and Kanban. Work should be organized in small iterations, use dashboards to visualize and monitor work, hold meetings to maintain team collaboration and integration, and remove impediments.

The hybrid construction project management methodology combines the processes of Standard 21500:2012 with the agile methods Scrumban andLean Construction to integrate the traditional and agile approach throughout the project lifecycle; seeking rapid innovation, focus on results andcontinuous delivery and value, solution to the current complexity and team integration and communication in construction projects.[28–36]

The process groups of the hybrid methodology developed are the following: Initiation. Iterative- adaptive planning and execution, both monitored and controlled throughout the project life cycle. Closure. Figure 3 shows the model of the hybrid methodology processes for construction projects. Projects are by nature integrative; integration withiterative relationships is paramount in the hybrid methodology since the tasks include all process groups. In Figure 4, the integration model of the process groups during the entire project life cycle is presented. Iterative/adaptive planning, the foundation of the hybrid methodology, is mostly applied in projects where change is continuous and unpredictable. It is carried out in advance at a high level and is adapted through constant feedback, incorporation of changes and replanning according to the progress and actual events of the project. Figure 5 shows the flow of activities that must be considered to elaborate an iterative planning, which is carried out continuously and allows the correction of the plan in case of deviations for the achievement of objectives. Using iterations in a construction project offers many advantages: it allows gathering short-term priority requirements, defining the scope more clearly, detailing the work breakdown structure more precisely, estimating the execution time andbudget more accurately. It is important to providedaily feedback and to perform the retrospective orreview of the iteration at the end of the establishedtime.

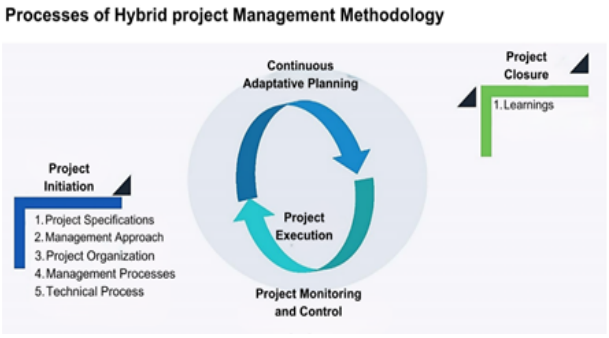

Figure 3 Processes of the hybrid project management methodology for the construction sector.

Source: Standard 21500:2012 and Agile Practical Guide. Elaborated by Y. Frangakis.

In Figure 6, a model of the processes involved in an iteration is presented to facilitate the release of priority project deliverables on time. And in Figure 7, the activities to be considered in each iteration are shown.

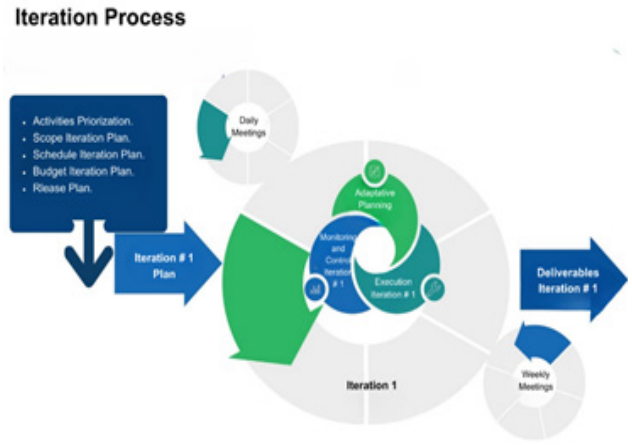

Figure 6 Process model of an iteration**.**

Source: Practical guide to agile. Elaborated by Y. Frangakis.

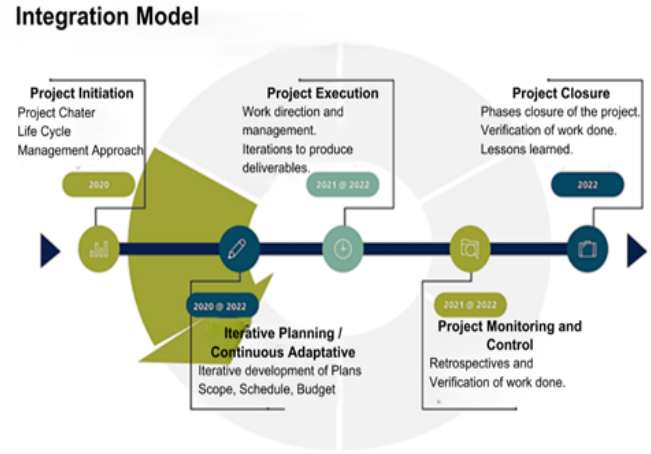

Figure 4 Integration subject group model.

Source: Standard 21500:2012, Practical guide toagile. ElaborationY. Frangakis.

Figure 5 Flow of activities to elaborate an iterative planning.

Source: Standard 21500:2012, Practical guide to agile. Elaboration Y. Frangakis.

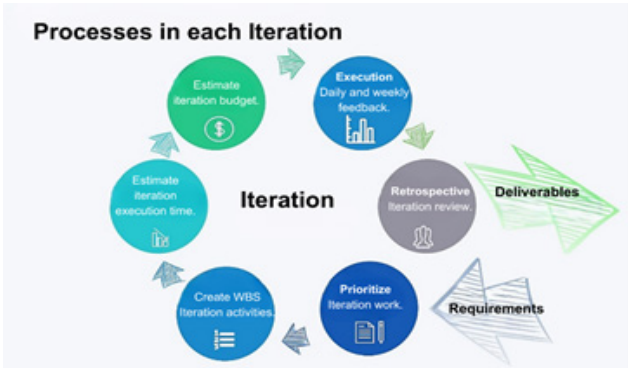

Figure 7 Activities when performing an iteration**.**

Source: Practical guide to agile. Elaborated by Y. Frangakis.

If the scope, objectives, or risks sof the project are not completely clear from the beginning, by applying the hybrid methodology, it is possible to define them in a general way at the beginning andto detail them as the project progresses. With each iteration you gain more information, clarity ofrequirements and customer needs, and should include the real problems that are discovered during execution. The

hybrid methodology is mostly applicable to complex projects with some degree of uncertainty, where the scope becomes better known as the project is executed. To comply with the execution time, the restrictions that prevent the normal development of activities must be analyzed, iterations and weekly planning framed within the initial schedule or the project's master plan must be applied. To strengthen compliance with this constraint (time), which is currently only met in 63.41% of construction projects, the hybrid methodology defines a plan, and the work is executed in short cycles to review results and adapt as necessary. Priorities may change and the plan will need to be adjusted, rapid feedback is required on the work executed and the adequacy of deliverables through iterative scheduling that allows for easy planning, organizing, and prioritizing. In time management, it is important to establish real and achievable objectives, identify and plan the tasks according to the time established in the iterations and prioritize them. Figure 8 shows the processes to be carried out in each iteration to estimate the execution time of the project deliverables. A tool that contributes to the achievement of time compliance is "Last Planner". Its application is simple, requires strict compliance, and is based on increasing the performance of construction activities by decreasing planning uncertainty. As shown in Figure 9, the master plan covers all project activities from inception to completion. The intermediate or iteration plan is derived from the master plan and can be made for a time frame of one to three months. The weekly plan is determined based on the intermediate or iteration plan and contains the activities to be executed each week budget.

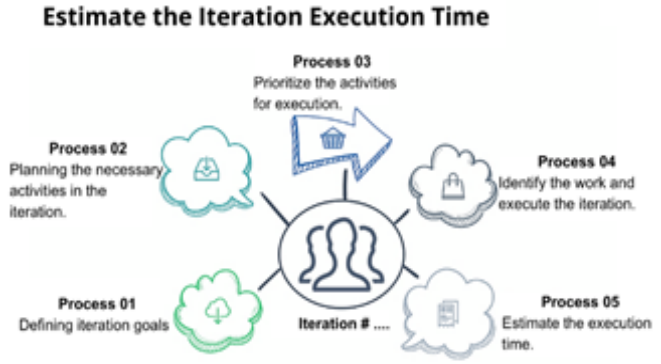

Figure 8 Processes for estimating execution time in a hybrid approach project.

Source: Practical guide to agile. Elaborated by Y. Frangakis.

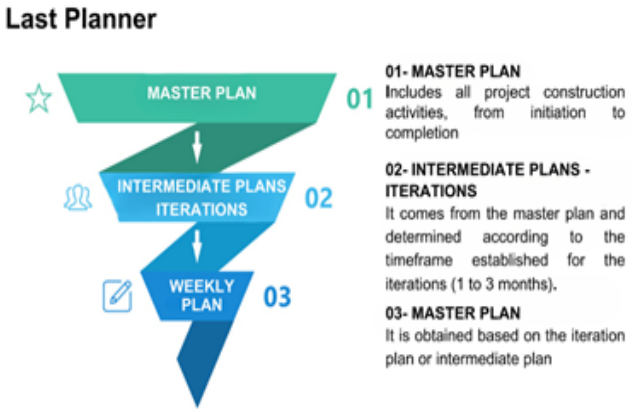

Figure 9 Application of Last Planner in time management. Elaborated by Y. Frangakis.

The second constraint of construction projects, with the lowest compliance percentage, is the budget. Often hybrid approach projects that are characterized by high variability may also be subject to tight budgets as one of their main constraints; as such, the scope and schedule must be adjusted frequently to stay within cost constraints. In this type of project, detailed estimates are made in short-term planning in a just-in-time mode.[37–49]

Delphi technique: validation of the hybrid project management methodology

The Delphi technique was the validation instrument used in this research. It consisted of the systematic use of an intuitive judgment issued by a group of national and international experts in project management who, through rounds of anonymous questionnaires, made evaluations and contributed their opinions to achieve a consensus for the validation of the hybrid project management methodology applied to construction. The choice of experts for the validation of the hybrid methodology developed in this research was based on: their professional competence, taking into account their years of experience, academic or scientific level, publications on project management, level of knowledge and updating, as well as the results obtained from the analysis of the k competence coefficient.

The competence of the experts was measured from the competence coefficient k, calculated as shown in equation (2), where *kc* is the coefficient of knowledge and *ka* is the coefficient of argumentation of the experts, which was influenced by their own theoretical analysis, experience, the work of national and international authors, and knowledge of the state of the problem.

$$k = \frac{1}{2}(kc + ka) \tag{2}$$

The validation process by means of Delphi Technique consisted in the elaboration of three questionnaires where each of the important points of the development of the hybrid management methodology for construction projects were ordered, classified and hierarchized, the criteria in the design of the questionnaire were the following: Logical order and clarity in the questions. Short questions. No questions that implied conditioned answers or implicit questions were asked. Questions were asked on the most important points to validate the methodology developed.

The questionnaire consisted of 27 variables with closed questions for which the Likert scale was applied in their responses with a range of 1 to 5. After analyzing the results of the questionnaire, the analysis was shared with the experts and, based on their contributions, the questions of the variables that showed the greatest dispersion were reformulated.

The statistical results used in the validation of this research were: the measures of central tendency and dispersion (mean, median, mode, maximum, minimum and standard deviation). The Likert scale was applied to the questionnaires: Not Appropriate (1), Not Very Appropriate (2), Appropriate (3), Fairly Appropriate (4), Very Appropriate (5). Table 3 below presents the final descriptive statistical results of the variables of the validation questionnaire of the hybrid methodology for construction projects. According to the statistical results obtained from the validation of the present research using the Delphi Technique; the value obtained was "3.903", which indicates that the application of the hybrid project management methodology in the construction sector is "quite appropriate". The value of the Cronbach's Alpha coefficient obtained from the final validation questionnaire of the Hybrid Project Management Methodology for Construction Projects was 0.946, confirming the reliability of the validation results (Table 4).

Table 3 Descriptive statistical results of the variables of the final validation questionnaire by delphi technique of the hybrid methodology of construction project management

Descriptive statistics			
Var.	**Description**	**Mean**	**Dev.**
1	¿By utilizing a Hybrid Project Management Approach throughout its lifecycle, are the results improved in execution and the achievement of final objectives?	3.63	1.061
2	¿Will using a Hybrid Project Management Methodology for construction projects, where the Traditional Methodology is complemented with Agile Methodologies, improve the final project outcomes and increase value deliveries to the client?	4.38	0.744
3	The tools and techniques provided by Agile Methods such as Scrum for variable and highly uncertain construction projects; Lean (Last Planner) for medium to low uncertainty projects; combined with the Traditional Methodology are applicable to construction projects	3.63	0.744
4	¿ The Hybrid Project Management Methodology should be applied considering the specific characteristics and constraints of each construction project?	4.5	0.926
5	In the Hybrid Project Management Methodology for construction projects, 'continuous adaptive planning' is applied, and process groups are conducted continuously throughout the project lifecycle with iterative relationships.	3.75	0.886
6	The Hybrid Project Management Methodology for construction projects interrelates process groups and their outcomes in each iteration, achieving a comprehensive vision and fulfilling final objectives.	3.5	0.756
7	¿ Are the processes to be carried out in each iteration considered appropriate?	3.63	1.302
Descriptive statistics			
Var.	**Description**	**Mean**	**Dev.**
8	The Hybrid Project Management Methodology for construction projects implements daily meetings of no more than 15 minutes with each team member to review the day's work plan and the completion of yesterday's tasks to eliminate obstacles and maintain team alignment with the iteration plan.	4.13	0.835
9	The Hybrid Project Management Methodology for construction projects implements team meetings at the end of each week to review and analyze performance data and information obtained, allowing for improvements in execution and adherence to the iteration plan	3.63	1.061
10	The Hybrid Project Management Methodology for construction projects implements retrospective meetings at the end of each iteration to evaluate the performance of completed work and seek possible improvements.	3.88	0.835
11	¿ Is the following content of the Management Plan appropriate for a construction project executed using a hybrid management approach??	3.5	0.535
12	The Hybrid Project Management Methodology for construction projects implements constant feedback and continuous re-planning through iteration planning meetings, where the iteration results are detailed, and the next iteration is planned	3.38	1.061
13	The Hybrid Project Management Methodology for construction projects implements a General Plan model where scope, schedule, and budget are outlined at a high level initially and then detailed in each iteration.	3.75	1.035
14	The Hybrid Project Management Methodology implements the prioritization of activities according to client requirements to deliver functional outputs in less time.	4	0.756
15	The Hybrid Project Management Methodology for construction projects implements a model for developing the Scope, Schedule, and Budget Plan through iterations.	3.63	1.302
16	In a construction project where there is a limitation in funds, the Hybrid Project Management Methodology for construction projects allows for the utilization of available funds for priority activities that generate value for the project owner, as identified through the iteration schedule and budget.	3.25	1.165
17	The Hybrid Project Management Methodology for construction projects implements the utilization of an iterative work plan based on short cycles and agile release planning to obtain deliverables from prioritized areas and value outcomes.	3.5	1.414
18	The Hybrid Project Management Methodology for construction projects implements evaluating the quality of work performed in iterations and identifying root causes of problems if they exist, then seeking solutions for improvement.	4.25	0.707
19	The Hybrid Project Management Methodology for construction projects implements the involvement of the project team in both planning and delivering completed activities.	4.25	0.707
20	The Hybrid Project Management Methodology for construction projects promotes constant communication with the team to resolve potential obstacles, ensure clarity, and understanding of the work to be done in the iteration.	4.25	0.886
21	The Hybrid Project Management Methodology for construction projects implements risk identification in each iteration.	4.5	0.756

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Table 3 Continued...

22	In construction projects with medium to high uncertainty, the Hybrid Project Management Methodology for construction projects implements the use of contracts that allow greater flexibility to change; consideration should be given to the activity to be contracted and the particularity of each situation.	4.38	0.916
23	The Hybrid Project Management Methodology for construction projects promotes stakeholder participation to facilitate decision-making.	4	0.756
24	The Hybrid Project Management Methodology for construction projects implements weekly metric reviews to compare the amount of work executed with the estimated amount of work to determine the schedule status and make necessary corrections.	3.38	0.916
25	The Hybrid Project Management Methodology for construction projects implements the use of Task Boards, daily meetings, retrospectives, along with other control tools and techniques typically applied in construction and selected according to the project's particularities.	4.13	0.835
26	The Hybrid Project Management Methodology for construction projects monitors the completion of iteration activities weekly through an indicator of the percentage of activities completed.	4.38	1.061
27	The Hybrid Project Management Methodology for construction projects implements the use of technological integration tools, dashboards for data analysis and visualization, for efficient and real-time control of project execution.	4.25	0.707

Table 4 Final statistical results of the validation questionnaire

	Mean	Minimum	Maximum	Variance	N of elements
Element stockings	3.903	3.25	4.5	0.149	27
Element variances	0.878	0.286	2	0.177	27
Covariances between elements	0.321	-0.607	1.5	0.111	27
Correlations between elements	0.392	-0.63	1	0.126	27

The aspects that allowed for positively assessing the reliability of the results are as follows:

- Stability and quality of the experts who participated in the validation, with a high competence coefficient k of the experts.
- The time elapsed between rounds was approximately one month, with a total time of approximately six months spent on validation using the Delphi Technique.
- Consensus among the opinions of the experts.
- Stability of the results between rounds.

In Table 5, the values of the Cronbach's Alpha are presented, indicating the reliability of the final validation questionnaire through the Delphi Technique.

Table 5 Cronbach's alpha value obtained

Reliability statistics		
Cronbach's alpha	**Cronbach's alpha based on standardized items**	**N° of elements**
0.94	0.946	27

Limitations and implications

The main limitation of implementing a hybrid project management methodology in construction is the resistance to change typically encountered among professionals when attempting to make improvements to the processes they are accustomed to, even if the expected results are not achieved. In construction projects, the project team is usually temporary, so it is necessary consider the time needed for training and adaptation to successfully implement the hybrid project management methodology in construction projects and truly reap its benefits. The resistance of construction companies to the use of a standardized hybrid methodology for project management, assuming it entails additional costs. The hybrid methodology for construction project management has been validated by subject matter experts. As a future endeavor, its implementation is proposed in the construction projects of an organization aiming to improve the results obtained during project execution. The results of this research confirmed that the hybrid project management methodology can be applied in the construction industry, offering significant benefits throughout the project's development. Additionally, they lay the foundation for new questions, ideas, and open up new lines of work. Future lines of research could specifically focus on one of the agile methods that are more closely aligned with the characteristics of construction projects and develop a hybrid methodology based on traditional project management methodology supplemented by a specific agile method, such as Lean Construction or Scrumban. Another potential future line of research could be the development of a Practical Guide to construction based on the hybrid methodology, focusing on one of the specific process groups of the construction project lifecycle, such as planning, scheduling, monitoring, and control.

Conclusion

By means of the Delphi Method, the research hypotheses were tested. It was validated that standardizing project management processes through the application of a hybrid project management methodology (traditional supplemented with agile methods) with tools, techniques and templates helps to achieve project and company objectives. The main contribution of this research is to contribute to the development and growth of project management through a methodology that integrates the benefits of the two major existing project management methodologies (Traditional-Agile) that allows the efficient use of resources, remaining flexible to changes and competitive in the current business environment.There is no single methodology for managing construction projects; the methodology to be used will depend on itscharacteristics, among which the traditional methodology and the hybrid methodology (traditional methodology combined with agile tools or methods) stand out. Due to the special characteristics of construction projects, not all agile methods are applicable. The use of agile tools and techniques in a construction project depends on its variability, level of uncertainty, technical and team characteristics.

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By applying the hybrid methodology in each of the process groups of a construction project, selecting the agile methods according to their particularities;value is added to the project in each of itsprocess groups and consequently in the project objectives. Using the continuous adaptive planning tool and iterations in construction projectshelps to keep the execution plan in accordance with the real situations that occur during the execution of the project and therefore provide clarity in the actual completion of the project. A construction project can also increase itsvalue by making partial deliveries according to the priorities andrequirements of the stakeholders. This also accelerates project acceptance. An integral vision is essential for the fulfillment of the final objectives of a construction project, this can be achieved by applying the Hybrid Management Methodology interrelating the process groups and their results in each iteration.Obtaining quality and accurate information in a timely manner allows to take the necessary corrections to achievesuccessful results. In a construction project it is important to obtain constant feedback, this can be achieved through the Hybrid Methodology by implementing retrospective meetings at the culmination of each iteration and evaluating the performance of the completed work to seek improvements. Communication and participation of the team throughout the project cycle is essential to maintain constant feedback, timely detection of problems and thus provide early solutions, replanning and not affecting the final time objectives. In a construction project it is relevant to consider the training, motivation, cohesion, and integrity of the project teamas it is a key factor for the success or failure of the project. It is very important the weekly monitoring of the fulfillment of the activities of the iteration by means of an indicator of the percentage of the fulfilled activities, sincewhat is measured is the only thing that can be improved. The implementation of technological integration tools, dashboards for data analysis and visualization allow efficient control and real-time monitoring of projectexecution, and it is important that the team has the appropriate technical qualifications.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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