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EXPLORING AND ASSESSING THE UTILIZATION OF BEST PRACTICES FOR ACHIEVING EXCELLENCE IN CONSTRUCTION PROJECTS

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Abstract: Many construction projects face cost overruns and schedule delays. To improve the project efficiency and reduce the unintended outcomes of these challenges, Construction Industry Institute (CII) has developed several construction Best Practices (BPs). Although implementing all CII BPs would be beneficial for construction projects, it may not be a practical approach. Therefore, there is a need to develop a decision-making framework for the selection process of the most beneficial BPs. The aim of this paper is to provide a constructive approach and develop a decision-making guideline to assist Project Managers (PMs) with the selection and implementation process of five CII BPs (Team Building, Alignment, Change Management, Front End Planning and Partnering) which lead to the greatest cost savings and schedule reduction for the owner entities. For this reason, a structured survey was developed to collect information on project physical and managerial characteristics, the implementation level of the mentioned CII BPs. Forty-four responses were collected. Through several statistical analysis including the two-sample *t*-Test, Kruskal-Wallis test, and Chi-squared test, the researchers were able to determine the significant project characteristics, which are the main drivers of selecting and implementing construction BPs. The results of the analysis indicate that "interfaces among project participants", "project resources", and "scope definition" are the three primary determinants in the selection and implementation process of the five mentioned BPs. The findings of this research will help the owners and PMs to select and invest in BPs, which optimize the project development process and reduce the potential schedule delays and cost overruns significantly in the construction industry.

1 INTRODUCTION

Cost overruns and schedule delays are two major challenges in construction industry, and there is a goal to minimize the unintended outcome of these two problems in construction projects. For this reason, CII has focused on studying strategies and BPs, which could improve construction projects'

performance. Construction Industry Institute (CII) which is one of the leading organizations in the area of construction studies has developed several BPs, which could improve construction projects' performance. CII has defined construction Best Practice as "a process or method that, when executed effectively, leads to enhanced project performance". These BPs which optimize project cost and schedule performances, could benefit either of owner and contractor entities or in some cases advance the design and construction process, which lead to a major gain for all the three primary stakeholders. Although financial loss for any of the construction stakeholders causes significant damages, however, the increased project cost during the execution phase may result in severe harmful consequences to the owner entity. Authorization of extra funding late in the project may not be a possible and practical option for some public owner entities and therefore, the on-going construction project may be temporarily/permanently suspended. As a result, this study focuses on the five following BPs which save project cost and time for the owner entities significantly: (1) Team Building, (2) Front End Planning, (3) Project Change Management, (4) Alignment, and (5) Partnering (CII-IR166-3).

CII recommends PMs to implement more of the mentioned BPs to all construction projects. However, it is not practical to implement all CII BPs due to the limitation of available financial and human resources. Therefore, there is a need to study and develop a framework for the selection process of the most beneficial BPs to yield the best outcomes in construction projects. As a result, this study focused on the two following objectives: (1) identify the potential project characteristics, which could be the criteria for the selection of BPs and (2) test the significance of these variables to determine which of them are the main drivers of selecting BPs for implementing in construction projects. The outcome of this research adds a significant value to the current body of knowledge and helps owners in the field of construction to select the most beneficial BPs wisely.

2 LITERATURE REVIEW

The nature of working in construction projects is susceptible to cost overruns and schedule delays (Assaf, S.A. and Al-Hejji 2006, Kaliba et al. 2009, Perrenoud, A. J. and Sullivan, K. T. 2013, Aziz, Remon Fayek 2013). Cost overruns and schedule delays can occur due to various reasons based on different types of construction projects. For instance, it can be because the estimate was not either accurate or the execution process was not performed well (Kermanshachi, 2016). Several studies recommended that implementation and adoption of proper strategies could significantly help in the management of large-scale complex projects (Kermanshachi et al., 2016, Dao et al., 2016). The construction organizations tend to implement applicable BPs in their projects in the hope that these strategies optimize projects' performance. In this regard, many significant studies have been conducted to study the impact of implementing a single or multiple BPs (CII RS3-1, CII IR32-1, Weston et al. 1993, Fischer and Tatum 1997, Thomas 1999, Jergeas and Revay 1999, Jergeas and Van der Put 2001, Thomas et al. 2004, Lee et al. 2004, Akpan 2009, Akpan et al. 2014, CII IR 166-3).

As it is shown in Table 1, this study focused on the implementation of the five BPs, which lead to significant cost and schedule reduction for the owner entity (CII IR 166-3). The second and third columns of Table 1 illustrate the stakeholder entity which benefits the implementation of the BPs and the cost and/or schedule type of benefit respectively. The fourth column shows the owner's cost and/or time savings/losses due to the low or high implementation of each of these BPs. The "Total Savings" column displays the different between low and high implementation of the mentioned BPs. The last column presents the total performance improvement of construction project. The definition of each of the five selected BPs is represented in the following sections.

2.1 Project Change Management

According to the definition of CII (IR166-3), Change Management is "an organization's process of incorporating a balanced change culture of recognizing, planning, and evaluating project changes to effectively manage them. These changes include scope, error, design development, estimate adjustments, and change condition, either elective or required". As shown in Table 1, high

implementation of project Change Management strategy leads to 1.2% cost savings for the owner entity. On the other hand, low implementation of this strategy may cause 10.2% cost overrun for the owner stakeholder.

Table 1- Benefits of implementing Best Practices

Best Practice	Benefiting Entity	Saving Type	Benefiting Entity's Savings with Different Implementation Levels		Total Savings	Total Project Performance Improvement
			Low	High		
Change Management	Owner	Cost	10.2%	-1.2%	11.4%	
Partnering	Owner	Cost	2.4%	-6.7%	9.1%	10% cost saving 20% schedule reduction
Alignment	Owner	Cost	5.4%	-3.3%	8.7%	9.8% cost saving 16.1% schedule reduction
Front End Planning	Owner	Cost	6.4%	-2.2%	8.6%	10% cost saving 7.2% schedule reduction
Team Building	Owner	Schedule	6.0%	-1.0%	7.0%	

2.2 Partnering

The definition of Partnering is "Partnering may involve a long-term commitment between two or more organizations, as in an alliance, or it may apply to a shorter period of time, such as the duration of a project. The purpose of Partnering is to achieve specific business objectives by maximizing the effectiveness of each participant's resources. This requires changing traditional relationships to ones that exist within a shared culture without regard to organizational boundaries. These relationships are based on trust, dedication to common goals, and mutual understanding of individual expectations and values" (IR166-3). As illustrated in Table 1, high implementation of Partnering strategy leads to 6.7% cost savings for the owner entity, while low implementation of this strategy may yield 2.4% cost growth for the same entity.

2.3 Front End Planning

Based on the definition of CII (IR166-3), Front End Planning is "the process through which owners develop sufficient strategic information to address risk and commit resources in order to maximize project success". As shown in Table 1, high utilization of Front End Planning strategy in construction projects leads to 2.2% cost savings. However, low adoption of this Best Practice results in 6.4% cost increase for the owner entity.

2.4 Alignment

The alignment strategy has been defined as "The condition under which appropriate project participants are working within acceptable tolerances to develop and meet a uniformly defined and understood set of project objectives. Aligning the project team involves developing clearly understood objectives for all team members and gaining the commitment from each to work toward those goals. At the end of the alignment process, each member is focused on the same set of project objectives" (CII IR166-3). The high adoption this strategy in construction industry leads to 3.3% cost saving for the owners while low implementation of Alignment causes 5.4% cost increase in construction projects.

2.5 Team Building

CII has defined Team Building as “a project-focused process that builds and develops shared goals, interdependence, trust and commitment, and accountability among team members. It also seeks to improve team members’ problem-solving skills” (IR166-3). As presented in Table 1, high use of Team Building strategy in construction industry leads to 1% time saving and low use of this Best Practice may result in 6% delays.

3 RESEARCH METHODOLOGY

To meet the goals and objectives of this study, a six-step research methodology was developed. As it is illustrated in Figure 1, the first task was to review the recent literature to determine the high benefiting BPs for the owner entities. In the second task, the research team identified and categorized the potential project physical and managerial characteristics, which could be the main drivers of BP implementation. Next, a structured survey was developed to collect data on project physical and managerial characteristics as well as their level of BPs implementation. The data were then qualitatively analyzed to evaluate the collected data according to their project size and duration, delivery method and contracting type. In the fifth Task, several statistical testes were utilized to identify the main project characteristics drivers of the selection and implementation of the mentioned strategies. At the end, the final research results were interpreted and discussed.

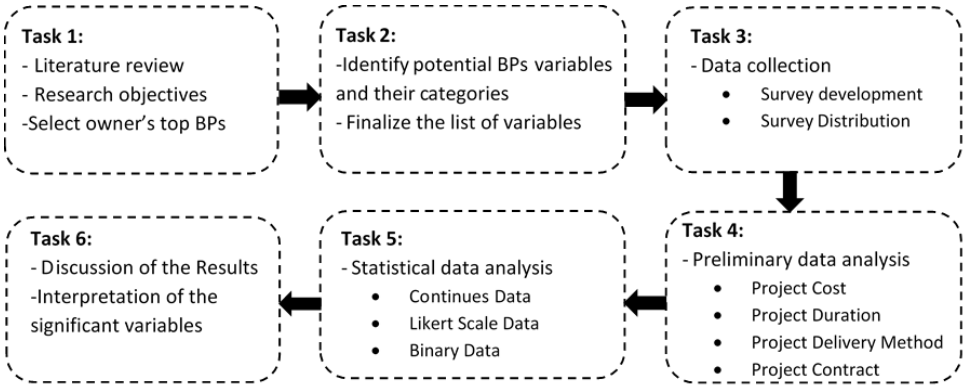

Figure 1: Research Methodology Process

According to the literature, the identified project characteristics could be categorized into 11 categories (Dao et al., 2016). Eleven categories are listed as follows: (1) Location; (2) Interfaces; (3) Stakeholder management; (4) Governance; (5) Legal; (6) Fiscal planning; (7) Design and Technology; (8) Project resources; (9) Quality; (10) Scope definition; (11) Execution target. Each of the categories contains several number of potential BPs variables.

To verify if the identified potential BP’s variables are significant to the selection and implementation of the mentioned BPs, several statistical analysis were performed. Since different type of data (continuous, Likert scale, binary) was collected, both parametric and nonparametric tests were utilized. To test the significance of the collected continuous, Likert scale, and binary data, Two-sample *t*-Test, Kruskal-Wallis test, and Chi-squared tests were utilized respectively. These statistical analyses were utilized to test the following research hypothesis:

- Null Hypothesis (H0) - The identified BPs variables are not significant in driving the Best Practices.
- Alternative Hypothesis (H1) - The identified BPs variables are significant in driving the Best Practices.

To assess this hypothesis, the data collection and analysis techniques were driven. Ninety-two potential BPs variables were identified and each of these potential variables were converted to a survey question.

4 DATA COLLECTION

As mentioned earlier, through the review of the existing literature, the potential project-based characteristics, which drive the selection decision of BPs were identified and categorized. This study intended to determine which of the Best Practices should be implemented based on the project characteristics. To fulfill this objective, a comprehensive survey inquiring data about project characteristics, EPC cost and schedule performance, and the implementation level of each of the best practices was developed.

The developed survey, which contained 97 open- and close-ended questions, was divided into the three following major sections: (1) General projects characteristics, (2) Project potential Best Practices metrics, and (3) Best Practices implementation level. The first part of the survey provided sufficient instructions to the participants and asked the respondents to fill the entire survey based on a recent completed construction project. General project characteristics consisted of 20 multi-section questions acquiring information about projects type, project baseline and actual cost and schedule, entity-driven change order value, project delivery method, etc. The next part of the survey, Project Best Practices metrics, obtained information about 72 potential project characteristics, which may drive the selection decision of Best Practices. The last section of the questionnaire, Best Practices implementation level, inquired information about the implementation level of each of the mentioned five BPs.

To pretest the developed survey, the questionnaire was sent to four Subject Matter Experts (SMEs). The researchers asked SMEs to review the potential project characteristics, which may drive the selection of the Best Practices. The pretest participants were also asked to assess the survey for the clarity of the questions. The questionnaire was then distributed among construction professionals and active practitioners who have at least a decade of work experience. After several follow-up emails, 44 completed survey responses were collected.

5 DATA ANALYSIS AND RESEARCH RESULT

5.1 Preliminary Data Analysis

Thirty out of forty-four collected projects belonged to heavy industrial projects, and the rest belonged to light industrial projects, building projects, and infrastructure projects. The projects' actual costs were between $0.4 million and $5.6 billion, with an average of $284 million. In addition, the projects' durations were from 8 months to 70 months, with an average duration of 28 months. In addition, 34% of the collected projects adopted Design-Build delivery method, 32% selected Design-Bid-Build, 25% utilized Multiple-Primes, and 8% proceed with CM at risk delivery method. Regarding to the selected construction contract type, 52% of the projects were executed under cost reimbursable contract type while the rest were proceeded with lump sum contract type.

5.2 Statistical Data Analysis

The Best Practices metrics were statistically tested to determine if there is a significant difference between the BPs implementation levels based on each of the 92 project characteristics. Depending on the three types of continuous, Likert scale and binary survey data, the appropriate statistical test was selected. Two sample t-test, Kruskal-Wallis test and Chi-squared test were utilized to investigate if there is a significant difference between low and high BPs implementation level for continuous, Likert scale and binary variables respectively. As it is illustrated in Table 2, this study initially performed the statistical analysis at the 0.05 (shown with *) significance level and then raised to 0.1 (shown with **) to include more potential project variables.

Table 2- Significant Team Building variables and corresponding *P*-Values

BP	Category	Best Practice Variable	*P*-Value
Team Building	Location	Number of countries involved in engineering/design phase	0.090*
		Impact of project location on project execution plan	0.026**
	Interfaces	Communication effectiveness within designer/engineer group	0.001*
		Communication effectiveness within subcontractors and contractors group	0.001*
	Stakeholder management	Alignment quality of external stakeholders	0.050**
		Alignment quality of internal stakeholders	0.001**
		Clarity of owners project goals and objectives	0.024**
	Governance	Number of sponsoring entities (owners)	0.075*
	Fiscal planning	Clarity of funding process during Front End	0.036**
	Design & Technology	Companies familiarity with technologies involved in operation phase	0.054**
		Companies familiarity with technologies involved in construction phase	0.071*
		Difficulty in system design and integration	0.017**
	Project resources	Field craft labor quality issues	0.013**
		Percentage of PM staff turnover	0.018**
		Reuse of existing installed equipment	0.083*
	Execution target	Planned percentage of engineering/design completion at the start of construction	0.080*
	Scope definition	Change management process followed by key project team members	0.045**
		Clarity of projects scope during designer/contractor selection	0.076*
		Clarity of change management process	0.091*
		Project scope similarity level at completion compared to authorization	0.020**

As it is shown in Table 2, number of countries involved in the project design/engineering process is an indicator that suggests Team Building strategy implementation would significantly save project time for the owners and avoids probable delays. Team Building strategy, which promotes trust and accountability among project participants, creates shared goals between stakeholders and therefore, reduces potential time-consuming disagreements and conflicts. Also, if the owner perceives that project internal and external stakeholders may not align well, it is recommended that the owner adopts Team-building strategy to improve the quality of communication among project primary and secondary stakeholders and motivates project participants to perform towards the achievement of the united goal. In addition, if the scope of a construction project is not clearly defined prior to the selection of the designer or contractor entities, or the scope of the project changes significantly throughout the execution process, utilization of the Team-building strategy is highly recommended.

Implementation of Front End Planning (FEP) enables the owner to address project risks properly and provide the required resources to maximize project success. As it is illustrated in Table 3, implementation of this strategy reduces project cost overrun when the owner and designer/engineer have no prior collaboration experience. Moreover, adoption of FEP allows the owners to proactively plan and address the possible construction phase craft labor and material quality issues early in the project. Furthermore, utilization of FEP strategy reduces the associated risks of new technologies and improves project cost performance. In addition, the implementation of Front End Planning strategy leads to obtain favorable outcomes when change management process is not defined clearly or not followed by key project team members throughout the project.

Table 3- Significant Front End Planning variables and corresponding *P*-Values

BP	Category	Best Practice Variable	*P*-Value
Front End Planning	Interfaces	Number of designer/engineer organizations	0.023**
		Previous Collaboration Between Owner and Designer/Engineer	0.055*
	Stakeholder management	Number of Active External Stakeholders in Decision Making Process	0.013**
	Governance	Number of Change Order Approval Above Project Manager	0.09*
	Fiscal planning	Clarity of Funding Process during Front End Planning	0.071*
	Design & Technology	Company's Familiarity with Technologies Involved in Operation phase	0.068*
		Company's Familiarity with Technologies Involved in Construction phase	0.097*
	Project resources	Field Craft Labor Quality Issues	0.059*
		Bulk Materials Quality Issues	0.014**
	Scope definition	Change Management Process Followed by Key Project Team Members	0.099*
		Clarity of Change Management Process to Key Project Team Members	0.073*
		Change Management Process Effectiveness in Controlling Cost and Schedule	0.041**

As it is shown in Table 4, adoption of Change Management Best Practice will enhance the project cost performance when several engineering firms are involved in the design process. Involvement of multiple design entities in a single project may cause several changes in the process of project development due to increased number of errors. These errors which are caused due to the miscommunications between independent design firms, could be potentially addressed by the incorporation of change culture into the project environment. Also, if it is perceived that there might be a high percentage of labor craft turnover due to the difficult job site condition and/or competitive execution location, implementation of Change Management could provide effective proactive adjustment plans. In general, when the goals and objectives of a project is not clearly defined, or if the funding process of the project is not evidently communicated, implementation of Change Management is highly recommended.

Table 4- Significant Change Management variables and corresponding *P*-Values

BP	Category	Best Practice Variable	*P*-Value
Change Management	Location	Number of Execution Locations-Engineering/Design Phase	0.058*
	Interfaces	Number of Subcontractor Project Management Leadership Team Members	0.012**
		Number of Permitting Agency Project Management Leadership Team Members	0.031**
		Number of Designer/Engineer Organizations	0.041*
		Previous Collaboration Between Owner and Designer/Engineer	0.086*
		Previous Collaboration Between Designer/Engineer and Contractor	0.042**
		Communication Effectiveness within Contractors Group	0.096*
	Stakeholder management	Clarity of Owners Project Goals and Objectives	0.009**
	Fiscal planning	Clarity of Funding Process during Front End Planning	0.027**
		Impact of Project Economics on Obtaining Funding	0.089*
	Project resources	Delay in Delivery of Permanent Facility Equipment	0.042**
		Field Craft Labor Quality Issues	0.038**
		Bulk Materials Quality Issues	0.042**
		Permanent Equipment Quality Issues	0.022**
		Percentage of Craft Labor Turnover	0.059*
	Execution target	Schedule Target at Authorization Compared to Industry Benchmarks	0.070*
	Scope definition	Change Management Process Followed by Key Project Team Members	0.060*
		Clarity of Projects Scope During Designer/Contractor Selection	0.001**
		Clarity of change management process to key project team members	0.028**
		Project Scope Similarity Level at Completion Compared to Authorization	0.089*

As it is indicated in Table 5, if in a construction project, the owner perceives that there might be ineffective communications and interactions among the primary and secondary stakeholders; this study suggests implementing the Alignment strategy to develop clear goals to all team members. Alignment strategy adoption leads to align attitudes, values, and environment of team members and therefore, increases the communication effectiveness within and between project stakeholders. Ultimately, this best practice makes the involved team members more committed and allows them to focus on the same set objectives. Moreover, Alignment strategy helps to develop and meet uniformly defined project objectives when the scope of the project has not been defined well during the designer/contractor selection. In general, adoption of Alignment strategy is highly suggested when various vendors and subcontractor organizations are involved in a construction project.

Table 5- Significant Alignment variables and corresponding *P*-Values

BP	Category	Best Practice Variable	*P*-Value
Alignment	Location	How many different countries worked on the construction phase	0.051*
		Impact of Project Location on Project Execution Plan	0.005**
	Interfaces	Number of Subcontractor Project Management Leadership Team Members	0.049**
		Number of Subcontractor Organizations	0.036**
		Number of Vendor Organizations	0.082*
		Communication Effectiveness within Permitting Agencies Group	0.013**
		Communication Effectiveness within Contractors Group	0.006**
		Communication Effectiveness within Designers/Engineers Group	0.001**
		Communication Effectiveness within Owners Group	0.023**
		Communication Effectiveness between Subcontractors and contractors Group	0.020**
	Stakeholder management	Number of Active Internal Stakeholders in Decision Making Process	0.003**
		Alignment Quality of Internal Stakeholders	0.006**
		Clarity of Owners Project Goals and Objectives	0.014**
		Impact of Required Inspection by External Agencies	0.028**
	Legal	Difficulty Level in Obtaining Design Approvals	0.001**
		Number of External (Regulatory) Agencies Required to Approve Design	0.088*
		Impact of External Agencies on Project Execution plan	0.022**
	Fiscal planning	Clarity of Funding Process during Front End Planning	0.032*
	Project resources	Delay in Delivery of Permanent Facility Equipment	0.001**
		Frequency of Workarounds - Unavailability of Materials	0.004**
		Field Craft Labor Quality Issues	0.004**
		Bulk Materials Quality Issues	0.057*
		Permanent Equipment Quality Issues	0.024**
		Percentage of Craft Labor Turnover	0.023**
		Percentage of PM Staff Turnover	0.001**
	Execution target	Planned Percentage of Engineering/Design Completion at the Start of Construction	0.001**
	Scope definition	Clarity of Projects Scope During Designer/Contractor Selection	0.007**
		Clarity of change management process to key project team members	0.033**
		Project Scope Similarity Level at Completion Compared to Authorization	0.017**

Partnering best practice is recommended when the project may face future funding delays as it is indicated in Table 6. The Partnering strategy could help project participants to overcome these challenges by utilization of the other entity's financial resources. Moreover, if the change management process is not effective in controlling project cost and schedule, Partnering implementation would be very beneficial since it provides a framework to foster change in participants' attitudes from adversarial to cooperative, and from win/lose to win/win. Moreover, when a construction project has more than a one sponsoring entity with several layers of funding gates, utilization of Partnering strategy could significantly enhance the project cost and schedule performance.

Table 6- Significant Partnering variables and corresponding *P*-Values

BP	Category	Best Practice Variable	*P*-Value
Partnering	Location	Number of Execution Locations-Engineering/Design Phase	0.073*
		How many different countries worked on the detailed engineering/design phase	0.032**
		Impact of Project Location on Project Execution Plan	0.012**
	Interfaces	Number of Subcontractor Organizations	0.009**
		Number of Vendor Organizations	0.001**
		Communication Effectiveness within Contractors Group	0.032**
		Communication Effectiveness within Designers/Engineers Group	0.001**
		Communication Effectiveness between Subcontractors and contractors Group	0.036**
	Stakeholder management	Number of Active Internal Stakeholders in Decision Making Process	0.003**
	Governance	Number of Sponsoring Entities (Owners)	0.036**
		Number of Financial Approval Authority Thresholds	0.010**
		Maximum Number of Authority Levels Above PM-Change Order Approval	0.016**
	Fiscal planning	Number of Funding Phases	0.079*
		Project Funding Delays	0.015**
		Impact of Project Economics on Obtaining Funding	0.051*
	Design & Technology	Difficulty in System Design and Integration	0.036**
		Number of New Systems Tied into Existing Systems	0.066*
	Project resources	Field Craft Labor Quality Issues	0.010**
		Permanent Equipment Quality Issues	0.031**
		Percentage of Craft Labor Turnover	0.029**
		Percentage of PM Staff Turnover	0.005**
		Percentage of Bulk Materials Sourced Locally - Within Project Country	0.069*
	Quality	Degree of Additional Quality Requirements - Construction Specifications	0.008**
		Degree of Additional Quality Requirements - Materials Specifications	0.062*
	Scope definition	Change Management Process Followed by Key Project Team Members	0.037**
		Clarity of Projects Scope During Designer/Contractor Selection	0.009**
		Clarity of change management process to key project team members	0.009**
		Project Scope Similarity Level at Completion Compared to Authorization	0.009**
		Change Management Process Effectiveness in Controlling Cost and Schedule	0.007**
		Impact of Request for Information (RFI) on Project Design	0.002**

6 CONCLUSION

The intend of this study was to provide a constructive methodology and develop a decision-making framework to assist PMs and practitioners with the selection of five CII BPs (Team Building, Alignment, Change management, Front End Planning, and Partnering) in construction projects. Implementation of these five mentioned BPs leads to significant cost saving and schedule reduction for the owner entity. In this study, the physical and managerial characteristics of 44 construction projects were collected. Three statistical analysis methods (two-sample *t*-Test, Kruskal-Wallis test, and Chi-squared test) were then used to define the significant variables in the selection process of each of the BPs. This study concluded that clarity of scope definition is a determinant indicator in the implementation of Team Building, Partnering, and Change Management Best Practices. On the other hand, project interfaces, stakeholder management, legal, and project resources are the basis for the selection of the Alignment strategy. In addition, it is recommended that the decision of Partnering strategy adoption should be made based on project's fiscal planning, project resources, and material quality. The findings of this study assists PMs and owners to invest in BPs which yields the greatest cost and schedule savings.

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