

Integration of the Project Team in Delivery Methods and Procurement Procedures

Christofer M. Harper, PhD
Colorado State University
Fort Collins, Colorado

James Angerman
Louisiana State University
Baton Rouge, Louisiana

Project team integration is a concept incorporating relational contracting concepts of cooperation, trust, and collaboration to create a team for designing and constructing projects. A construction project team is similar to creating a temporary organization to complete a project. Yet, project teams differ based on the project delivery method and the procedure for procuring the primary design and construction organizations. In order to understand the applications of project team integration and the influence that delivery methods and procurement procedures have on the overall integration of the project team, this study aimed to measure integration using relational contracting expected behaviors and compared the measured overall integration of a project team from projects using various delivery methods and procurement procedures. To accomplish this, a survey questionnaire was distributed to construction industry professionals registered with DBIA and CMAA that collected project information as well as measured the integration of the project team using relational contracting expected behaviors. A total of 281 responses were collected, which included projects delivered using design-bid-build, design-build, and construction manager at risk and procured using low bid, best value, and qualifications-based selection. A two-way analysis of variance statistical evaluation was used to determine the impact that project delivery methods and procurement procedures have on the integration of the project team measured using relational contracting expected behaviors. The results statistically showed that different delivery methods have the ability to achieve higher levels of team integration, while procurement procedures showed no impact on the integration of the project team.

Key Words: Integrated Project Teams, Alternative Contracting Methods, Procurement Procedures, Relational Contracting

Introduction

When a construction project is undertaken, owners have the ability to influence how the project team forms and ultimately how the team works together throughout design and construction of a project. Two decisions that the owner makes directly impacts the creation of the project team, which are choosing the project delivery method and the procedure to procure the primary construction organizations. The formation of and continuous interactions between the contractual project team can affect the overall outcome of a project in a positive or negative way.

Research in the areas of project delivery methods and procurement procedures has received extensive attention in recent years. Delivery methods help dictate how projects proceed from planning, to design, and through substantial completion, while the procurement procedure dictates the process for hiring a construction firm. In either case, delivery methods or procurement procedures do not directly influence the integration of the project team, but rather influence the establishment of the project team and the level of integration that is achievable within those project teams.

While project delivery and procurement have been researched through many studies, integration of the project team and relational contracting is limited in construction research, but has received more attention in recent years due to the impacts now being realized with the use of integrated teams and integrated delivery methods (Franz et al. 2017). Integrated project delivery (IPD) is the next step in the progression of delivery methods due to its apparent nature to create and sustain a conducive team that focuses on the project and shares in its risks and rewards. However, making

the leap from the more traditional and common delivery and procurement systems to integrated methods is difficult due to the major changes in how projects are contracted.

Traditionally, construction contracting more resembles transaction contracting rather than more integrated relational contracting (Williamson 1979). In relational contracting, the relationship between contracting parties goes beyond the written contract, and establishes a relationship based on common goals and interests (Macneil, 1980). Relational contracting focuses then more on the people involved rather than the processes and procedures included in the contract. Therefore, this research conducted focuses on how the delivery method and procurement procedure affect the relationship between contracting parties beyond the written contract, or in essence, the integration of the project team. This paper discusses delivery methods and procurement procedures and how integrated the project team is in each method as well as investigates the effect that integrated project teams have on construction projects.

Project Delivery Methods

Project delivery methods is a topic that receives much attention in construction due to the many options that are now available for public and private sector projects. Three methods in use today include design-bid-build (DBB), design-build (DB), and construction manager at-risk (CM at-risk). The DBB method is the most traditional delivery method and it distinctly separates the design, bidding, and construction phases of the project. The owner first enters into a contract with a designer and then enters into a contract with a constructor using contract documents prepared by the design and owner (CMAA 2012). Since DBB is the most traditional delivery method, owners, designers, and contractors have clearly defined roles. Yet DBB introduces an atmosphere that is highly competitive, adversarial and does not allow inter-organizational trust to develop. This negative atmosphere can lead to the unwanted results of cost overruns, time overruns, and low quality, which in turn leads to impending liability claims and litigation (Clough et al 2015). Due to negative factors, DBB does not lend itself to establishing and sustaining an integrated project team.

Design-Build involves one primary contract between the owner and one firm to complete both the design and construction of a project. The project duration is typically less when compared to DBB due to overlapping design and construction, and there is a reduced possibility for requests for information and change orders because of construction input during the design phase. The contractual relationship allows for collaboration, especially between the contractor and designer that represent the design build firm. However, the owner typically relinquishes more control of the design to the design-builder compared to other delivery methods, which may impede the integration of the project team fully (Kenig 2011).

One method of delivery that includes early constructor involvement and allows the owner to retain more control and input in the design is CM at-risk. The CM at-risk delivery method allows the owner to contract with a separate designer and a separate constructor, similar to DBB. Yet, the difference is that the owner hires both of these firms during the planning or design phase of the project so that the constructor can provide input as the designer develops the project design. By allowing contractor input, constructability can be improved as the team is formed earlier in the process and during a time when changes are much more manageable and easier to incorporate. With early formation of the primary construction parties, more time is available for positive relationships to develop, leading to a more collaborative atmosphere (Gransberg and Shane 2010).

Procurement Procedures

Currently, most projects procure firms with low bid, best value, or qualification-based selection. Low bid procurement is a competitive, closed bid system that selects a constructor solely on total construction cost as long as the bid is fully responsive (Clough et al 2015). This procedure implies an “auction approach” to bidding because it tells potential firms that cost is the owner’s first priority (Warne et. al 2005). With price the first, and in many cases the only, priority beyond providing a responsive bid, there is a lack of establishing a team from the very start of team formation.

In contrast to low bid procurement, qualifications-based selection (QBS) is a procurement option that exclusively uses the qualifications of a construction firm and price is not a factor. The qualifications can be any number of items, such as past relevant experience, qualifications of key personnel, or capacity to complete the work (El Wardani et al 2006). After selection based on qualifications, the owner negotiates with contractor to formalize the scope and determine a "fair and reasonable" price for the work. The approach to qualify a contractor and the negotiated style of determining a fee provides a more transparent procurement approach and helps to establish the project team as the contract is being formed.

The procurement procedure known as Best Value is a melding of both QBS and low bid. In best value procurement, the combination of price and qualifications or technical aspects assist with selecting the constructor for the project (Kenig 2011). The owner decides on how they weigh the value of cost portion and the value of qualifications/technical portion, and then uses those factors to determine which contractor to select. With the selection process including the component of qualifications, the project team begins to be formed early on.

Project Integration

Based on the general descriptions of project delivery methods and procurement procedures, the apparent differences reveal that integration of the project team can vary depending on the delivery and procurement used. As an example, a study by El Asmar et al (2013) investigated the performance of common delivery methods of DBB, DB, and CM at-risk to the performance of integrated project delivery (IPD) projects across a series of performance factors related to cost, schedule, quality, safety, and other areas of importance. The results showed improvements in 14 of the metrics across six performance areas when using IPD over other delivery methods. This research detailed below then explores the impact of delivery methods, as well as procurement procedures, on integration of the project team.

Research Methodology

The basis for this project is the research conducted by Harper et al (2016), which created a tool for measuring integration of project teams using relational contracting expected behaviors called contractual norms. This project builds on the previous research by using the project integration tool as well as a new focus solely on the effects and interactions that may exist between procurement procedures and delivery methods within the integration of a project team.

The data collected in Harper et al (2016) used an electronic based survey questionnaire. The survey questionnaire was developed using an extensive literature review, psychometrics, industry experts and piloting (Harper et al (2016). To distribute the survey, professionals registered with the Construction Manager Association of America (CMAA) and the Design-Build Institute of America (DBIA) we selected as the sample population. Data collection occurred over a six week period. The initial invitation was sent via email individually to all potential respondents along with an anonymous link to complete the survey electronically. A reminder was then sent every two weeks for six weeks to all potential respondents that had not yet completed the survey. Overall, 314 fully responsive survey questionnaires represent the data set where each response focused on one specific project that the survey participant had been involved with within the last seven years.

The survey questionnaire contained demographics and characteristic questions such as type of delivery method, procurement procedure, project location, project value, and participant's role in their organization. The survey tool also collected data that measured the integration of construction project teams using the project integration measurement tool (Harper et al 2016). The project integration measurement tools utilizes eight contractual norm factors, which are measured using multiple statement items with a five-point Likert scale that ranked from "Strongly Disagree" (1 point) to "Strongly Agree" (5 points). The eight contractual norms, from relational contract theory, are role integrity, reciprocity, flexibility, contractual solidarity, reliance and expectations, restraint of power, propriety of means, and harmonization of conflict (Macneil 1980). Each of these contractual norms represent a specific aspect of relational contracting that enhances the integration of the project team when proper behaviors are present in a contractual relationship or deteriorates the project team when detrimental behaviors are present.

Table 1 lists the independent and dependent variables used in the data analysis. The independent variables, delivery method and procurement procedure, are nominal data. The dependent variable, the total integration score of the project team, is a total score of the Likert-based statement items from the eight expected contractual behavior measures. The total integration score is interval level data that allows for the use of parametric statistical analysis. The use of parametric analysis of variance is a more powerful tool than the use of non-parametric tests, and drawing conclusions and interpretations of the parametric analysis are easier to understand and provide more information than non-parametric tests (Jakobsson 2004).

Table 1

Independent and Dependent Variables for Analysis of Variance

Variable	Categories/Measures	
Delivery Methods (Independent)	Design-Bid-Build Design-Build CM at-Risk	
Procurement Procedures (Independent)	Low Bid Best Value Qualifications-Based Selection	
Total Integration Score (Dependent)	Role Integrity Reciprocity Flexibility Contractual Solidarity	Reliance and Expectations Restraint of Power Propriety of Means Harmonization of Conflict

Analysis and Discussion

In this project, the authors used two-way analysis of variance (ANOVA) statistical methods on the data set using SPSS. A two-way ANOVA was deemed appropriate as the data analyzed consists of collected data for the delivery method and procurement procedures, and collected measured data representing the total integration score for each of the projects. A two-way ANOVA has the ability to show the effect that one set of variables has on another set, which is the focus of this research, to determine the effect delivery methods and procurement procedures have on project team integration. In order to create the interval data of total integration score for each project, the measured integration contractual norm measures were summed together. A high integration score translates to a higher perceived level of integration for a project while a low integration score translates to a lower perceived level of integration for a project (Harper et al 2016). Following the two-way ANOVA, post hoc test was conducted for any results found to be statistically significant.

Before conducting the ANOVA, the first step is to generate the descriptive statistics for total integration score across the different combinations (or interactions) of delivery methods and procurement procedures used on the construction projects collected in the data set. Table 2 summarizes the descriptive statistics for each of the nine combinations of delivery methods and procurement procedures. Reviewing the mean integration score shows that scores are lower for DBB projects than DB projects and that CM at-risk scores are higher than DBB and DB projects. Furthermore, low bid has an average integration score lower than best value and QBS. These initial results support the fact that DBB traditionally shows less integration among the project team when compared to DB and CM at-risk. Low bid also traditionally does not promote team integration.

Table 2

Descriptive Statistics for total integration score across procurement procedures and delivery methods

Delivery Method	Procurement Procedure	Integration Total Score					
		N	Mean	Variance	Min	Max	Range

Design-Bid-Build	Low bid	94	137.32	603.166	58	183	125
	Best value	34	143.38	524.971	104	182	78
	QBS	6	128.17	731.767	88	160	72
	Total	134	138.45	591.422	58	183	125
Design-Build	Low bid	8	147.75	832.214	89	183	94
	Best value	49	144.04	566.373	64	185	121
	QBS	29	147.03	520.177	84	189	105
	Total	86	145.40	562.218	64	189	125
CM@R (CMGC)	Low bid	10	148.50	254.056	117	166	49
	Best value	19	151.58	234.480	126	182	56
	QBS	32	142.66	788.620	52	177	125
	Total	61	146.39	532.609	52	182	130
Total	Low bid	112	139.06	594.474	58	183	125
	Best value	102	145.23	491.899	64	185	121
	QBS	67	143.25	673.677	52	189	137
	Total	281	142.30	579.425	52	189	137

The 314 completed survey questionnaires included 134 DBB, 86 DB, 61 CM at-Risk, eight integrated project delivery (IPD), five public-private partnerships (P3), eight multi-prime, and five job order contracting projects. With sample sizes less than ten for IPD, P3, multi-prime, and job order contracting, the decision was made to eliminate these projects from the analysis. The small sample sizes create an opportunity for results to be skewed by a single submission. For example, job order contracting projects had only five completed surveys, and all five projects used low bid. Additionally, only five projects listed sole source as the procurement procedure used, and therefore sole source was not included in the analysis. After excluding the delivery methods and procurement procedures with small sample sizes, the data set includes 281 DBB, DB, and CM at-Risk projects for use in this research analysis.

The proper sequence for performing an ANOVA evaluation of a data set includes investigating shape, then spread, then location. For shape, the initial test is to determine if the data is approximately normally distributed. When a data set is normally distributed the ANOVA evaluation works well and the results are less likely to be skeptical.

For the test for normality, a statistical program called MVP Stats was used to test the cellular combinations of delivery methods and procurement procedures. With three categories each for delivery methods and procurement procedures, nine combinations need to be tested for normality.

In reviewing the sample sizes for each of the nine combinations of delivery methods and procurement procedures, sample sizes are unequal and four of the nine combinations have a sample size of 10 or less. When sample sizes are small in tests for normality, it is more appropriate to investigate normality using the Anderson-Darling statistic rather than the moment statistics of skewness and kurtosis (Razali and Wah 2011). In performing the Anderson-Darling statistic of normality in MVP Stats, the results shown in Table 3 reveal that four of the nine combinations show significance. With significance showing, these combinations are inferred to not be normally distributed.

Table 3

Test for Normality Distribution

Pair	N	Mean	Anderson-Darling Statistic	P-Value
DBB – Low Bid	94	137.32	1.469	*0.000**
DBB – Best Value	34	143.38	0.652	*0.090**
DBB – QBS	6	128.17	0.206	0.870
DB – Low Bid	8	147.75	0.436	0.300
DB – Best Value	49	144.04	1.068	*0.008**
DB – QBS	29	147.03	0.349	0.478
CM at-Risk – Low Bid	10	148.50	0.444	0.287
CM at-Risk – Best Value	10	151.58	0.265	0.708

CM at-Risk – QBS	32	142.66	1.107	*0.006**

**Denotes significance at the 0.010 level*

The lack of full normality distribution for each of the nine delivery method – procurement procedure combinations means that the ANOVA for variance will test for dispersion using Levene's Improved Test, which allows the ANOVA to be used although full approximation of normality was not realized (Luftig and Jordan 1998).

The Levene's Improved Test for analyzing the variance of data tests the dispersion of values from the mean. Levene's improved test required the use of absolute deviation from the median (ADM) values to determine if the dispersion is equal or not for each of the different combinations of delivery methods and procurement procedures (Luftig and Jordan 1998). The authors computed the ADM values and then transferred the values to SPSS for the ANOVA test. Table 4 presents the results of the Levene's Improved ANOVA for dispersion.

Table 4

Two-Way ANOVA of ADM Values Results

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	P-value
Delivery	461.52	2	230.76	0.865	0.422
Procurement	345.19	2	172.59	0.647	0.524
Delivery × Procurement	551.42	4	137.85	0.517	0.723
Error	72,562.61	272	266.77		
Total	158,938.00	281			

In reviewing the results of the dispersion ANOVA, neither of the main effects of delivery method or procurement procedure show significance. The interaction between delivery method and procurement procedures is also non-significant. One can then infer that the differences between the variance values seen in the delivery methods, procurement procedures and the combination of delivery methods and procurement procedures are due to sampling error and are not a result of the actual data set model. One can then assume that the variances found for the main effects and interaction are equal.

With normality (shape) and dispersion (spread) tested, the final examination is the two-way ANOVA of the interaction score means. The results of the two-way ANOVA test from SPSS are presented in Table 5. Of the main effects, procurement procedures is found to not be significant with a p-value of 0.312, while delivery methods is found to be significant at the 0.10 type I error level with a p-value of 0.049. The interaction between delivery method and procurement procedure for total integration is also not significant (p-value of 0.463). The results infer that delivery methods affect the level of integration achieved on a construction project, while procurement procedures statistically do not. The interaction of the different combinations of procurement procedures and delivery methods also shows no effect on the integration of the project team.

Table 5

Two-Way ANOVA of Means Results

Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Sig.
Delivery	3,458.84	2	1,729.42	3.023	*0.049**
Procurement	1,338.72	2	669.36	1.170	0.312
Delivery × Procurement	2,066.53	2	516.63	0.903	0.463
Error	155,608.02	272			
Total	5,852,204.00	281			

**Denotes significance at the 0.10 level*

With the main effect of delivery method showing the only significance, a post-hoc analysis is performed with the delivery method variable to determine if and how much the integration scores differ between the three delivery

methods. A proper post-hoc test has to be performed so that the results are accurate based on the conditions of the test. In this case, dispersion is equal, so homogeneity of variance post-hoc tests can be used. Another factor to consider when choosing a post-hoc test is the sample sizes of the conditions tested. Since the sample sizes vary, the sample sizes are unequal. Therefore, the post-hoc comparison test has to be associated with homogenous variance values and unequal sample sizes. The most appropriate test for this situation is Tukey's Honest Significance Test or Tukey HSD (Dunnett 1980).

The results, included in Table 6, show the pairwise comparisons between integration score means for the three delivery methods of DBB, DB, and CM at-risk. In reviewing the pairwise comparisons, the mean integration scores are significantly different at the 0.10 significance level for DBB and DB as well as DBB and CM at-risk. DB and CM at-risk are shown to not be significantly different.

Table 6

Pairwise comparison post-hoc for delivery methods-integration main effect

Delivery Method Pairs	Mean Difference	Std. Error	P-value
Design-Bid-Build ←→Design-Build	-6.948	3.298	*0.090**
Design-Bid-Build ←→CM at-Risk	-7.946	3.687	*0.081**
Design-Build ←→ CM at-Risk	-0.998	3.996	0.996

**Denotes significance at the 0.10 level*

For point estimates of the mean integration score for each of the delivery methods, the Tukey HSD post-hoc test provides subsets of values for determining the difference between the three project delivery methods in terms of average integration score for a project. From the Tukey HSD results, the point estimate for average integration score for DBB projects is less than DB and CM at-risk, while DBB and CM at-risk show no significance in the differences of mean total integration score so that DBB and CM at-risk have the same average total integration score (see Table 7). DBB has the lowest integration score while DB and CM at-risk have the same but higher integration score compared to DBB. Overall, one can then infer that the use of DB and CM at-risk can provide higher levels of project team integration than projects that use DBB.

Table 7

Mean Total Integration Score Point Estimates

Delivery Method	Mean Total Integration Point Estimate
Design-Bid-Build	138.45
Design-Build	(145.40 + 146.39)/2 = 145.895
Construction Manager at-Risk	(145.40 + 146.39)/2 = 145.895

Overall, the research study reveals that delivery methods influence the integration of a construction team, while procurement procedures do not. Higher integration was found for project delivered using DB and CM at-risk when compared to DBB. Based on these findings and the descriptions of delivery methods provided earlier, alternative delivery methods such as DB and CM at-risk include components of relational contracting and team integration in their processes. For example, early involvement of key participants is a factor that lends itself to CM at-risk and DB, but not DBB. With earlier involvement of the contractor, more time is available to establish positive relationships long before construction begins (Laurent and Leicht 2019). Furthermore, contracts used for CM at-risk and DB can be open-book contracts, which allows for more transparency between contracting parties, which improves overall communication. DBB projects are typically lump sum and closed book, which does not allow for transparency between contracting parties.

Conclusion

Integration project teams have the ability to improve the success of a construction project, and that team can be enhanced with the use of alternative delivery methods. Fundamentally, this finding can inform owners and researchers alike that the project delivery decision, already known to be a very important and difficult decision to make, is significant when it comes to the integration of the project team. Further, the results provide evidence that integrating a project team is improved for delivery methods that include the construction firm during design and when a delivery method includes open communication and transparency, which are characteristics of DB and CM at-risk projects, but not necessarily DBB projects.

One limitation to note on this study is the lack of inclusion of IPD projects in the data set. The total projects collected that used IPD was eight. The small sample size does not lend itself to finding noteworthy and accurate results. However, this research study focused on the integration of the project team in delivery methods and the concept behind IPD is that the project team should be more integrated than in other delivery methods. Future research can look to explore more IPD projects to determine the level of integration and the effect that IPD has on the project team and compare it to other delivery methods.

Developing and delivering a project is a complex and important aspect of every construction project. Knowing how to better form the project team as well as how to induce continuous integration of project team players can provide owners and practitioners the tools for creating a conducive team that cooperates, trusts, and collaborates with one another. When that occurs, the probability of reaching positive outcomes of a project can become a reality.

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