The Need for Integrated Project Delivery in the Public Sector

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ABSTRACT

Integrated project delivery (IPD) has proven an effective delivery system in the private sector as evidenced in recently completed case study projects. Despite this success, case study researchers assert IPD is not currently being used in the public sector due to state laws limiting the delivery systems available for public owners and the difficulty of changing these laws. This paper examines a set of building construction projects undertaken by one public owner over a 12-year period; specifically the change orders associated with these design-bid-build projects. The authors analyze these change orders to determine whether this owner could have realized the same benefit as private owners if IPD had been available as a delivery method. The authors hypothesize that (1) owners often use change owners to ensure their own satisfaction post-design because the design intent does not match their specific requirements (i.e., owner requested changes), and (2) the collaborative nature of IPD would significantly lower the need for such changes, providing added value to the owner due to a more complete project scope being determined earlier and with contractor input during the design phase. This paper presents data to support these hypotheses illustrating the benefits of IPD for public owners, in turn building a compelling case for adopting IPD in the public sector.

INTRODUCTION

The delivery of construction projects over the past century has moved from a “master builder” concept where a sole entity was responsible for completely designing and constructing projects, to a fragmented model made up of specialty firms that sequentially design and construct projects with little interaction. Numerous studies reveal that the now prevalent Design-Bid-Build (DBB) delivery method provides a perceived all-encompassing project cost, but due to the lack of sufficient scope review and collaboration during design, adjustments are oftentimes necessary during construction to bring the projects in line with the owner’s actual needs. DBB contractual arrangements often incentivize individual, rather than whole-project, optimization that in turn frequently leads to adversarial relationships between project stakeholders. Integrated Project Delivery (IPD), a relatively new approach to design and construction, focuses stakeholders on total project success through collaboratively addressing the three common domains of project delivery systems:
project organization, operating system, and commercial terms binding the project participants (Thomsen et al., 2009). Widespread industry adoption has not occurred though, especially in the public sector where owners are limited by state and federal contracting requirements.

Change orders (COs) are used to modify contractor’s scopes of work after the start of construction, and are typically funded by owner contingencies. This paper examines COs on a set of projects undertaken by one public owner (all contracted under DBB) over a twelve-year period. This information was used to determine the reasoning and quantity of changes that were necessary to complete these projects to the owner’s satisfaction after the start of construction. Results imply that the use of a more collaborative delivery method such as IPD could have alleviated the need for many of these COs, suggesting it may be worthwhile to re-examine state and federal contracting laws to allow this delivery system.

PROJECT DELIVERY SYSTEMS

Prior to the industrial revolution having a “master builder” complete a project was the typical delivery method used across much of the civilized world. A master builder acted as the architect, engineer, and superintendent, he was responsible for design, surveying, lay-out, and management of each construction project according to the contract documents (Yates & Battersby, 2003). The master builder concept transformed into a delivery system with specialized design and construction firms that would focus on certain aspects or types of projects during the early 20th century. This shift went hand-in-hand with increased sophistication of buildings that required more specialized knowledge and equipment. This evolution led to what we know today as design-bid-build (Konchar & Sanvido, 1998). Decreased interaction and information sharing between entities was common with this separation of services, especially during the design phase, resulting in inefficient designs, increased errors and disputes, higher costs, and longer schedules (ibid). Many clients became dissatisfied with these issues, which led to other project delivery methods being developed, including construction management at risk (CMR), and design/build (DB). CMR and DB seek to increase the amount of information sharing between stakeholders earlier in the process through overlapping of the design and construction phases (ibid). Even with studies showing that alternative project delivery methods perform better than DBB, DBB is still the most prevalent method used today (Minchin et al., 2010; Oberle et al., 2009).

Even with the advent of DB and CMR, owners were still dissatisfied with the fragmented and inefficient project delivery processes used to complete their capital projects. Sensing a need for wholesale change in project delivery methodology, The Construction Users Roundtable (CURT) published whitepapers in 2004 and 2007 urging owners to demand more integrated design and collaborative project teamwork on their projects (CURT, 2004; Tsao et al., 2007). This call for action led to what is known today at Integrated Project Delivery (IPD). IPD is defined as “a method of project delivery distinguished by a contractual arrangement among a minimum of owner, constructor, and design professional that aligns business interests of all parties. IPD motivates collaboration throughout the design and construction process,
tying stakeholder success to project success, and embodies contractual and behavioral principles:” (NASFA et al., 2010) (Dale et al., 2012) Figure 1 lists these principles.

<table>
<thead>
<tr>
<th>Contractual Principles</th>
<th>Behavioral Principles</th>
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<tbody>
<tr>
<td>Key participants bound together as equals</td>
<td>Mutual respect and trust</td>
</tr>
<tr>
<td>Shared financial risk and reward based on project outcome</td>
<td>Willingness to collaborate</td>
</tr>
<tr>
<td>Liability waivers between key participants</td>
<td>Open communication</td>
</tr>
<tr>
<td>Fiscal transparency between key participants</td>
<td></td>
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<tr>
<td>Early involvement of key participants</td>
<td></td>
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<tr>
<td>Jointly developed project target criteria</td>
<td></td>
</tr>
<tr>
<td>Collaborative decision making</td>
<td></td>
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</tbody>
</table>

Figure 1 – IPD Contractual and Behavioral Principles (NASFA et al., 2010) (Dale et al., 2012)

Thomsen et al. (2009) propose that “project delivery systems have three basic domains within which they operate: the project organization, the projects “operating system”, and the commercial terms binding the project participants.” IPD methodology seeks to maximize projects success through an optimal alignment of these domains that fairly distributes risk, reward and decision-making amongst the participants. Target Value Design is one strategy used that collaboratively focuses design efforts towards meeting the expected cost goals established at the beginning of the process, as opposed to wasteful redesign often necessary when construction costs of completed designs come in higher than expected (Thomsen et al., 2009).

IPD is still in its infancy but is gaining notoriety as a legitimate project delivery method in the industry. Kent and Becerik-Gerber (2010) surveyed members of numerous owner, contractor and design organizations (both experienced and inexperienced with IPD), and determined that 65.9% of respondents did not feel that construction projects were delivered efficiently. Fewer change orders, cost savings, and shorter schedules were listed as the most beneficial aspects of IPD compared to other delivery methods (ibid). Nearly 60% of experienced respondents felt that IPD would work well with all project types, with 31.2% stating that civic/government projects would be the most appropriate (ibid). Respondents stated that “many public agencies are not able to secure construction contracts without open lump sum bidding, and there needs to be an industry-wide effort to lobby lawmakers to make the necessary changes in the governing codes to allow IPD methodology” (ibid).

Though widespread adoption of IPD has not yet occurred, case studies of completed IPD projects illustrate the successes realized by project stakeholders. In 2010 the AIA commissioned a study of six recently completed projects that used IPD or “IPD-ish” delivery methods (Cohen, 2010). In every case the projects met or exceeded owner’s expectation with respect to budget, schedule, design quality and sustainability, and also met the financial expectations of the designers and builders (ibid). Participants felt that much of this success was due to breaking down the typical silos of design and construction, and being able to more clearly define the project goals, costs, and risks through collaborative knowledge sharing earlier in the process than in typical delivery methods (ibid). This research was expanded in 2012 through surveying individuals involved in the first six projects as well as six additional
projects in regards to their motivations behind choosing IPD. The motivations included (1) market advantage, (2) cost predictability, (3) schedule predictability, (4) risk management, and (5) technical complexity (Dale et al., 2012). Dale et al. (2012) noted that other delivery methods may facilitate addressing these motivations, but the IPD structure of early involvement and collaboration between a diverse set of expertise areas may offer an advantage over more traditional methods.

Along with the empirical evidence that IPD is a value-adding project delivery method, statistical evidence also exists to support these claims. El Asmar et al. (2013) compared thirty five projects (12 IPD, 23 non-IPD) to determine if IPD projects performed better than non-IPD in regards to 31 metrics in nine separate performance areas. It was shown that IPD projects statistically perform better than non-IPD projects in 14 of the 31 metrics in the quality, communication, change performance, business, environmental and schedule performance areas (to a .05 significance level). IPD projects were shown to be completed at a higher quality, with superior delivery speed, a lower amount of required change orders, and without any significant increase in total project costs as compared to the non-IPD projects.

CHANGE ORDERS AND OWNER CONTINGENCY

Change orders are an unwanted but inevitable reality in construction. A CO is a formal addendum to the construction contract (after work has begun) that usually includes a change in work scope, as well as an equitable adjustment to the contractor’s reimbursable cost, and/or allowed time for project completion (O’Brien, 1998). Owner requests are the most common cause of COs as has been shown in numerous studies (Alnuaimi et al., 2010; Günhan et al., 2007; Hanna et al., 2004; Olawale & Sun, 2010). Design errors, lack of time spent during the design phase to clearly define the project scope, and the delivery system are also substantial factors (Hsieh et al., 2004; Keane et al., 2010; Konchar & Sanvido, 1998; Love et al., 2008; Riley et al., 2005; Stocks & Singh, 1999).

Owner project budgets typically include contingency funds meant to cover unexpected events. Owners often apply contingency amounts to projects intuitively (i.e., a fixed percentage of construction cost) as opposed to systematically through an analysis of events realized on previous projects. Günhan and Arditi (2007) studied nine public projects, and concluded that contingencies unnecessarily tied-up funds that could have been used for other purposes, such as commissioning other projects. They state that a systematic and well-managed process at the preconstruction stage of a project could eliminate or reduce the need to use contingency funds.

PROBLEM STATEMENT AND RESEARCH METHODOLOGY

As described previously, IPD is gaining traction as a legitimate project delivery method. Typical fragmented design and construction activities of the most prevalent project delivery method, DBB, has little stakeholder interaction which can lead to inefficient designs, increased errors and disputes, higher costs, and longer schedules. Change orders are the typical instrument used to rectify issues that arise after the start of construction. Too often these are used to bring projects in line with
an owner’s actual requirements or to correct design errors, both of which could be lessened if there was more cooperation during the design phase between the project stakeholders. Contingency funds are allotted cover change order costs, which unnecessarily ties up valuable capital that could be used for other purposes. IPD was developed to mitigate these issues through increased collaboration, and has been shown effective in meeting participant’s expectations of cost, schedule, and quality both empirically and quantitatively.

To date IPD has mainly been used in the private sector, as public contracting agencies are limited in their project delivery options by state or federal laws. Individuals experienced with IPD have expressed that civic/government projects would benefit from the IPD methodology, and that IPD should be an allowable delivery method. The purpose of this study is to collect change order data from a set of projects completed by one public owner, and compare this data with the current literature to determine if allowing IPD would be beneficial in the public sector based on the amount and type of COs that were necessary to complete these projects to the owner’s satisfaction. The hypothesis is that the public sector would realize the same benefits as the private sector, and that IPD would be of benefit to public owners.

Public Owner Background Information

The data used for this study was collected from a mid-sized public university (roughly 18,000 students) in the Midwestern United States. One department inside the University (referred to as the Department of Design & Construction or D&C) was responsible for managing the design and construction of all projects across the school’s main campus and two smaller satellite campuses. Projects ranged from small classroom renovations to new sports arenas. Construction procurement laws in the University’s state previously allowed public owners to use only multi-prime DBB on any project that was valued above $50,000.00. Changes to state law were enacted in late 2011 to allow alternative contracting methods such as single-prime DBB, CMR and DB, being one of the last states to do so. State procurement codes also required an owner controlled contingency (10% of contracted construction cost) be added to each project once a construction budget had been established to address COs.

The typical chain of events from the initial project request to the start of construction is shown in Figure 2. In 2000, D&C instituted a process that required project managers develop simple spreadsheets at the outset of a project to track financial items, such as total project budgets, contingency, prime contract amounts, and change orders (including descriptions and costs). Each change order executed by D&C had “Basis of Change Order” codes attributed per line item of the CO. Six codes were used, including error/omission, owner request, value engineering, differing condition, field resolution, and other.
RESULTS OF CHANGE ORDER ANALYSIS

Each project completed by the University between 2000 and 2011 was reviewed and project information compiled into one dataset from the individual project spreadsheets. The prime contracts and associated change orders for this study were broken down into four separate prime contract scopes of work: general contracting, mechanical, electrical, and environmental. General contracting (GC) included all contracts for building construction, sitework, exterior building renovation, roofing, asphalt paving, exterior concrete, interior renovation, and demolition. Mechanical included all contracts for plumbing, HVAC, piping, and fire protection. Electrical included all contracts for electrical, fire alarm, and data wiring. Environmental included all contracts for asbestos abatement that were broken out separately from any of the other prime scopes of work. Each change order was reviewed and the listed bases for change catalogued. In a few cases, the basis for change was not listed. In these instances, the description associated with the change order and any pertinent back up paperwork detailing what the change entailed was used to establish a basis for change. With over 2,000 change orders reviewed, the number of these instances was less than 50.

In summary, 215 projects with budgets totaling close to $277 million (which includes designer fees, owner furnished items, and other soft costs) were completed during the 12-year period. As shown in Table 1, 543 prime contracts were executed to complete these projects, for a total cost of just under $196 million. GC accounted for the highest count and dollar amount of the four prime scopes of work, almost double that of second place mechanical in both regards. The university issued 2,080 CO’s to complete these projects with a cost of just over $21 million, which equated to a 10.79% increase in construction costs. GC accrued the highest dollar amount of COs, accounting for over half the money spent. On a percentage of original prime contract
cost compared to CO cost, the two lowest cost scopes of work, electrical and environmental, had significantly higher percentages than the two highest.

<table>
<thead>
<tr>
<th>Scope of Work</th>
<th>Contracts</th>
<th>Change Orders</th>
<th>% of Prime Contract</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#</td>
<td>$</td>
<td>#</td>
</tr>
<tr>
<td>GC</td>
<td>216</td>
<td>$106,900,528</td>
<td>968</td>
</tr>
<tr>
<td>Mechanical</td>
<td>153</td>
<td>$54,362,035</td>
<td>565</td>
</tr>
<tr>
<td>Electrical</td>
<td>141</td>
<td>$33,617,916</td>
<td>516</td>
</tr>
<tr>
<td>Environmental</td>
<td>33</td>
<td>$49433</td>
<td>31</td>
</tr>
<tr>
<td>Totals</td>
<td>543</td>
<td>$195,729,912</td>
<td>2,080</td>
</tr>
</tbody>
</table>

Table 1 – CO Analysis Results per Prime Scope of Work

In regards to basis of change codes, 2,471 total were listed as shown in Table 2. Owner requested changes were the most prevalent being attributed to over half of all COs. Value engineering was the least prevalent basis of change, being attributed to only 1% of all COs.

<table>
<thead>
<tr>
<th>Basis of Change</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Request</td>
<td>1138</td>
<td>54.71%</td>
</tr>
<tr>
<td>Field Resolution/Existing Condition</td>
<td>660</td>
<td>31.73%</td>
</tr>
<tr>
<td>Error/Omission</td>
<td>252</td>
<td>12.12%</td>
</tr>
<tr>
<td>Differing Condition</td>
<td>200</td>
<td>9.62%</td>
</tr>
<tr>
<td>Other</td>
<td>198</td>
<td>9.52%</td>
</tr>
<tr>
<td>Value Engineering</td>
<td>23</td>
<td>1.11%</td>
</tr>
</tbody>
</table>

Table 2 – CO Analysis Results per Basis of Change Code

DISCUSSION OF RESULTS

The purpose of this study was to collect change order data from a set of projects and compare this data with findings from literature to determine whether or not the cause of the COs aligned with issues often mitigated by IPD implementation. In turn, this allowed the authors to assess if allowing IPD would be beneficial in the public sector. Previous research has shown that IPD is more effective in meeting project stakeholder expectations of cost, schedule, and quality than other delivery methods. The analysis in this study demonstrates that the DBB project delivery methodology did not meet the project cost or quality expectations established during design based on the CO data collected.

Three of the four prime scopes of work had CO percentages that were above the standard 10% contingency used to address CO’s, with the fourth prime being only slightly below this mark. This shows that additional work outside of the original scope was necessary to bring these projects in-line with the actual projects goals and needs. Electrical and environmental were substantially higher than the 10% allowance, highlighting two scopes that were significantly underdeveloped during the preconstruction phase of these projects. The typical chain of events during preconstruction (Figure 2) does not incorporate any contractor input prior to the proposal submission. With IPD, individual contracting firms would provide professional expertise to the means and methods of construction during the design process, as well as actively participate in assessing the existing conditions of project
workspaces. More inclusive and realistic project budgets would be created, and alterations could be made to the design to coincide with any budget restrictions.

Owner requested COs were the most prevalent basis of change on the studied projects, in congruence with previous CO research. Figure 3 illustrates that over the 12 year period, the percentage of COs to prime contract amounts trended downward, while Figure 4 shows that the prevalence of owner requested COs actually trended upwards over the same period of time. Though the trend analysis shows great variability in the percentages year to year (leading to low $R^2$ values), it is evident that as the percentage amount of COs per prime contract appeared to fall over time, the COs that remained were largely driven by owner requests. End user input was not elicited during preconstruction beyond the initial scope definition (Figure 2), which may, in part, explain this trend. In IPD, integration with the design and construction team members would provide clarity to the end user as to the actual project scope expressed in the construction documents. Thus, the need for owner requested changes may be reduced as the end user would have a more complete understanding of the intended project quality and cost prior to the start of construction.

![Figure 3 – Trend Analysis of CO % of Prime Contract Amounts](image)

![Figure 4 – Trend Analysis of Owner Requested Changes](image)
CONCLUSION

In the case of the owner’s projects used in this study, contingencies put in place to address design problems have been shown to be less than sufficient to cover the shortcomings of the DBB project delivery method used. Substantial amounts of COs were necessary to bring these projects in line with the owner’s actual needs and requirements. It is the hope of the authors that this research begins to substantiate claims that IPD would be a value-adding delivery method for use in the public sector. With this being said, IPD will not be the proverbial “silver bullet” in correcting all ills associated with the delivery of construction projects. IPD is still in its infancy and yet untested on a large scale, especially in the public sector. A cultural shift in the industry would need to occur for project participants to become comfortable working outside of their typical silos, and focus their efforts to collaboratively design and construct projects. Research has shown that individuals experienced with IPD feel it could be used on any project type, but because IPD has not yet been used extensively across sectors, this supposition is yet to be proven. As more and more projects are completed, research should focus on further identifying the benefits of IPD quantitatively, particularly in terms of added value and financial advantages as justification behind making significant changes (such as would be necessary to change procurement codes to allow IPD) are often driven through proof of these measures.

REFERENCES


