MULTISCIA
JOURNALS PUBLISHERS

FRONTIERS IN CIVIL ENGINEERING AND CONSTRUCTION MATERIALS

ISSN: (3065- 4181)




editor.fcecm@gmail.com

https://multisciajournals.com/journals/index.php/fcecm

Frontiers in Civil Engineering and Construction Materials
Volume 2 Issue 1 2026

A Better Familiarity with the Past, Present, and Future of Integrated Project Delivery in the Construction Sector

Govidhu C. Kent, and Burcin Becerik
Department of Civil

Article Info

Received: 24-01-2025 ***Revised:22-02-2025*** ***Accepted:08-03-2025*** ***Published:19-03-2025***

Abstract:
Collaboratively aligning the incentives and objectives of the project team via shared risk and reward, early engagement of all stakeholders, and a multiparty agreement is the purpose of integrated project delivery (IPD), which aims to enhance project results. There has been a lot of theoretical interest in IPD, but how far down the adoption curve the construction sector is. Despite the fact that a number of projects have shown IPD's worth and that several professional groups are calling for its further development, the number of projects actually using it is still modest. To better understand the present state of IPD usage and its potential for future broad acceptance by the construction industry, this study is based on the findings of a web-based survey that aimed to reach a diverse group of construction professionals. The purpose of this article is to provide empirical evidence on the attitudes, levels of knowledge, and experiences of construction industry experts with respect to IPD and its pros and downsides as a project delivery technique.

Introduction

Throughout much of the twentieth century, design-bid-build was the most popular mode of project delivery in the US, thanks to public procurement regulations that have supported it since the 1940s (Miller et al. 2000). Due to the increasing complexity of structures, the construction industry has become more specialized, leading to the segmentation of a process that was formerly overseen by a single master builder. Inefficiency, high levels of fragmentation, and the emergence of numerous cultures inside the sector were all outcomes of this strategy (Department of Commerce). as well as the significant expenses associated with insufficient interoperability (Gallaher et al., 2004). Although construction management (CM) has been beneficial to owners since its introduction in the 1960s (Tatum 1983), the fundamental issue of disjointed project teams and information remains unchanged.
The concept of design-build was first introduced in the 90s. Research done soon after design-build's inception found that, compared to more conventional ways of project delivery, it might enhance design-quality, timeliness, and cost (Kon-char and Sanvido 1998). Project alliancing was an effective delivery approach for a number of projects in the US at the same time that design-build was being developed.

various Australian infrastructure projects (Noble 2007). By bringing everyone on the team together and making sure they're all working toward the same objectives, this delivery strategy hopes to boost project results [Australian Department of Treasury and Finance (ADTF) 2006]. Integrative project delivery (IPD) is a relatively new approach to project management in the US that has lately evolved from project alliancing as its guiding principle.
In addition to its many other uses, IPD has emerged as a delivery mechanism that has the potential to greatly improve the efficiency of construction projects that make use of building information modeling (BIM). According to the Associated General Contractors of America (2006), building information modeling (BIM) is the process of creating and using a digital representation of a building that is data-rich, object-oriented, intelligent, and parametric in order to model the building's design, construction, and operation. Building information modeling (BIM) is both a technology and a technique that enables project team members to cooperate in an unprecedented way from the beginning of the design phase all the way through to occupancy (Eastman et al., 2008). By bringing everyone on the same page and offering incentives for tight cooperation at every stage of a project, IPD aims to foster the kind of collaborative environment that is necessary for making full use of building information modeling (BIM). Integration of building information modeling (BIM) with information process design (IPD) allows for a degree of cooperation that boosts efficiency, decreases mistakes, and opens up new avenues for investigation and growth in the market (Middlebrooks 2008).
The number of projects utilizing IPD is still relatively small, despite the fact that numerous professional organizations are advocating for its advancement [AIA California Council 2007; The Associ-ated General Contractors of America (AGC) 2009] and that multiple projects have shown its benefits (Post 2007; Matthews and Howell 2005). The adoption rate is poor for several reasons. There is a great deal of anxiety about the potential dangers of IPD and the tight collaborations that are required, and there is a pressing need for updated legal frameworks to reflect these changes. On top of that, a lot of people with a stake in the sector think that existing players should aim to absorb new competitors. expertise in areas like as information management and cooperation that might bolster IPD (Autodesk White Paper 2008). Despite the importance of IPD, very little is known about its present adoption status or the factors that have contributed to its sluggish acceptance in the business world (Sive 2009).
In order to better understand the future of IPD and what it would take for the industry to embrace it, this paper seeks to offer concrete

statistics about the amount of knowledge and experience that construction industry professionals have with IPD, as well as their thoughts on the pros and cons of this project delivery method. To start, we use the term "IPD" specifically for this research. The second part explains the research approach. This section provides an analysis of the survey data and a discussion of the findings. Finally, the results are summarized in the final comments, and suggestions are provided for further study and instruction on this issue.

IPD and BIM

Integration Project Delivery (IPD) is described by the American Institute of Architects (AIA) as "a process that collaboratively harnesses the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction" (AIA California Council 2007). It involves integrating people, systems, business structures, and practices. Establishing standards, disseminating recommendations, and promoting debates within their memberships that showcase successful projects and explore the challenges to adoption are being done by professional organizations like as AIA and Associated General Contractors of America (AGC). Notably, the AIA has released many papers that aim to define IPD and provide details on how its methods and principles might be used in building projects (AIA 2008). A collection of IPD contract agreements were released by ConsensusDOCS, an organization that was formed by 22 prominent construction associations (ConsensusDOCS 2009). According to Perlberg (2009a), the ConsesusDOCS 300 remains a multi-party IPD agreement and was the first conventional construction contract to handle IPD. Combined version of

According to Parrish et al. (2008), the International Financial and Project Obligation Agreement (IFOA) is a relational IPD contract that establishes the financial and contractual framework for partners in a construction project to effectively collaborate. Despite their best efforts, the industry still has not settled on a single, universally acknowledged definition of IPD. The word "IPD" is used to designate a broad variety of contact arrangements and team procedures due to its diverse meanings, methodologies, and levels of complexity (Sive 2009). On the other hand, most IPD initiatives and definitions have commonalities. Multiparty agreement, early participation of all parties, and shared risk and reward are the common elements that the authors employ to define IPD in this study. The idea that IPD may exist without any or all of these criteria has gained widespread acceptance. Similarly, there are other principles that may be regarded as im- portant for project success, but the three named principles have been selected due to their integral nature and inclusion in the majority of IPD projects and literature supporting IPD. Collective bargaining: The owner and the architect or general contractor normally enter into separate contracts under the conventional method of project delivery. In IPD, all parties with a significant stake in the project—including the owner, architect, general contractor, and others—enroll in a single contract that covers the whole endeavor. These contracts enable the principal objective of IPD—the maximization of collaboration and coordination throughout the project—to be accomplished without the impediment of distinct contracts that give rise to competing interests.

Shared risk and reward: Rather of focusing on a single team member, the majority of current IPD contracts include provisions meant to foster collaboration and further the project's success. By combining the risks and benefits of all team members and incentivizing collaboration to achieve shared project objectives, IPD contracts differ from conventional projects in which each party usually takes careful measures to reduce their individual risk. Though they could differ, these objectives are often linked to the time, money, and quality criteria that are used to evaluate a project's performance. An example of an associated risk includes covering budget overages with each entity’s overhead and profit, but if the project is under budget the team may receive a compensation bonus. The following risk/ reward sharing methods are found in literature:

Early involvement of all parties: One of the most fundamental advantages that IPD affords is the ability for all parties to be present and involved with a project from the earliest design phase. Early collaboration, under the right conditions, can directly ad- dress the problem of fragmentation between design and construc- tion professionals that results in inefficient work practices and costly changes late in the construction phase. While it is impor- tant to recognize that this early collaboration does not require the use of technological tools such as BIM, these tools can greatly increase the efficiency of collaboration throughout all phases of a project. BIM is poised to revolutionize the construction industry be- cause of its promise to radically improve collaboration among the wide ranging and expertise needed to design and construct a building and to increase efficiency (Bedrick and Rinella 2006). However, the perceived legal risks of moving from a two- to a three-dimensional (3D) industry are a major stumbling block for many companies to move aggressively into BIM (Perlberg 2009b). The absence of standard BIM contract documents and issues arising from how BIM is used as a collaborative frame- work are two major obstacles to fully adoption. Business models and contract relationships to reward “best for project” decision making should be established for widespread BIM adoption (Ash- craft 2008). There are also some constrains and difficulties of applying IPD. While new contracts supporting IPD exist, they have not been tested over time and are not fully proven or even understood. Also, the insurance industry does not yet have cover- ages for IPD. More important, construction industry firms are accustomed to traditional way of leadership, responsibility, and opportunity, and change is slow. Public institutions and agencies lack the authority to restructure their procurement processes to enable the IPD model. However, if implemented successfully, IPD can facilitate sharing of rewards and risks among stakehold- ers, create incentives for exceptional results, reduce operational and maintenance costs of the finished project, improve project delivery timelines, and reduce waste through better planning and shared costs (DeBernard 2008).

Research Methodology

Interviews

A significant amount of the information for this research was gained from interviews, which were conducted with 15 construc- tion industry professionals that are all knowledgeable and/or ex- perienced with IPD. The interviewees were initially selected from AIA's IPD Steering Committee, who referred the writers to other professionals that are experienced on the topic or involved with past or current IPD projects. All formal interviews were con- ducted over the phone, with three resulting in face-to-face inter- views. The process of developing and conducting interviews took about nine weeks between January 28 and April 1, 2009. Inter- views were conducted for two main purposes: to attain general information about IPD and its current use within the construction industry and to develop the appropriate constructs for the survey instrument. As a result of these interviews, it became obvious that there are little empirical data regarding IPD application and use in practice. In addition to the typical literature review, the qualitative survey in this research to garner initial data about practitioners' perceptions was needed. Results of the interviews were used to develop questions for the survey contained in this paper.

Survey

Purpose

The online survey was designed to target a wide range of profes- sionals in the construction industry and to determine the level of awareness, experience, and interest of the respondents regarding IPD. The goal of the survey was to answer the following ques- tions:

1. What is the current status of IPD adoption throughout the construction industry?
2. What are the knowledge and experience levels of each of the different stakeholders in the construction industry regarding IPD?
3. Are the various industry players satisfied with traditional de- livery methods and do they see a need for integrated delivery methods?
4. What factors attribute to the success or failure of IPD projects?
5. Does experience with IPD affect the attitudes of industry professionals toward this delivery method?
6. To what degree is BIM an integral component of projects that have used IPD?

Development

Survey questions were developed with information attained from interviews, general research, and literature reviews. The writers underwent five weeks of iterations regarding the type, amount, and configuration of questions between February 6 and March 13, 2009. A sample group from initial interviewees was chosen to test the appropriateness of the developed survey and to validate sur- vey questions and choices. The results were primarily analyzed for clarity check and data clustering. The intent of the survey was to attain information from individuals that are from the different disciplines of the construction industry. The survey breaks into three tracks of questions directed toward three different groups of respondents: those who are experienced with IPD (Group 1); those who are inexperienced though informed about IPD (Group 2); and those that are inexperienced and unfamiliar with IPD (Group 3). Many of the same questions were possessed to each group in order to determine if there is a difference in attitudes between those who are experienced (Group 1) and inexperienced (Group 2) with IPD. The greatest amount of questions is directed toward Group 1, which considers specific aspects of IPD as they are applied to actual projects. The survey was designed with a set of "logic" rules built into it. Two key questions facilitated the separation of three groups. These are as follow: "Are you cur- rently (or have you in the past) been involved with a project that utilized IPD or some form of collaborative agreement?" and "Are you familiar with the basic principles of IPD?" Based on respon- dent's answer to these questions, the survey administration tool automatically took them to the next set of questions.

Administration

The survey was hosted on https://new.qualtrics.com/ through an account funded by USC Viterbi School of Engineering. This web- based survey tool keeps a record of the computer's IP address from which the survey was completed and assigns an ID to each respondent. IP addresses and respondent IDs were downloaded and were checked for repeated entries and multiplicity. Qualtrics' analytical tools were used to analyze survey results.

Distribution

Owners, architects, engineers, general contractors, and project managers were the main recipients. Two methods of advertising the survey were used to ensure that as many professionals in the field as possible took part: first, via direct e-mail through distribution lists of several professional groups [The following groups and organizations are involved with building information modeling (BIM) and information process delivery (IPD): the Southern California Chapter of the Construction Management Association of America (CMAA), BuildingSmart Alliance, and the AGC Project Delivery Committee. Additionally, there are a number of media outlets that contribute to this field. There were no direct, individualized emails sent. It is difficult to ascertain the sample size since the poll was accessible to the whole industry. The 415 people who took the time to fill out the poll represent a good cross-section of the industry's specializations. In addition to revealing industry trends, the survey results provide valuable insight on the issue and the respondents. With 53% of the total replies collected on the same days that the distribution e-mails were sent, the survey had a six-week window from March 18 to May 1, 2009.

Survey Findings

Construction managers (38.1%), general contractors (18.3%), architects (17.3%), engineers (12.8%), and owners (10.6%) are the academic fields taken into account in this study, each accounting for at least 10% of the total survey takers. The following academic fields represented 5% or less of all respondents: administrative assistants, product designers, developers, suppliers, and manufacturers. Profile categories were created for respondents based on the specific personal information they gave. These groups included: executives (25.7% of the total), senior management (38.2% of the

total),

and lower-level employees (36.1%). Nearly two-thirds of those who took the survey were upper-level managers. This can be because of the survey's design or because upper management is particularly enthusiastic about the subject. Various seniority groups were used to examine the results, but no significant differences were discovered. The vast majority of responders (98.8%) were American citizens hailing from 30 different states. The state of California had the highest percentage of responses (34.9%). The efficiency of project delivery in the construction sector was one of the primary topics covered in the first survey (Fig. 1). In general, 65.9% of people feel that building projects are not completed efficiently. 84.1% of the architects, 72.2% of the general contractors, 61.6% of the construction managers, 59.6% of the engineers, and 51.2% of the owners think that construction projects are not delivered efficiently. Note that of the five fields, owners have the most hopeful outlook. Broken down, 68.2% of the respondents in Group 1, 76.7% of the respondents in Group 2, and 48.5% of respondents in Group 3 think that construction projects are not delivered in an efficient manner. It is interesting that respondents who are inexperienced with or uninformed about IPD are unsure (23.2% of Group 3) if construction projects are delivered in an efficient manner compared to the rest of the groups. Overall, this finding confirms that the perception of the industry players in 2009 regarding efficiency of construction project delivery is aligned with the findings of the study completed in 2004 (Gallaher et al. 2004). In the following sections, IPD experience and awareness among respondents is analyzed, characteristics of IPD projects are identified, and issues around IPD are discussed. Since owners have the most say on whether IPD projects are adopted, the per- ception of this particular group is singled out and highlighted when appropriate.

IPD Experience and Awareness

Figure 2 shows that 44.7% of the total respondents had dealt with IPD. Those who have never worked on an IPD project make up the remaining 55.3% of respondents, who are considered inexperienced. But among those without expertise, 55.1% know what IPD is (30.6% of the total). A total of 24.7% of the people who took the poll are ignorant and lack experience, making up 44.9% of the total. This study does not go any farther into this group. The findings reveal that most participants were either unfamiliar with the ideas of IPD or lacked firsthand experience with it. Because 20% of those who took the survey had no idea what IPD is, this result is significant because it shows that professional organizations aren't doing enough to educate and train their members. The fact that just under 50% of those who took the survey had worked on an IPD project before is encouraging, however. The following research shows that the informed group's and the experienced group's replies differ according to respondents' occupations, company sizes and revenues, and prior experience with various project delivery techniques.

Profession: Among the disciplines studied, architects had the greatest experience with IPD (58%), and they were also the best knowledgeable about it (86.2%; see Fig. 3). Just over half of the general contractors surveyed (51.4%) reported having prior experience with IPD. Building managers(42.0%), engineers(36.5%), and owners(30.2%) seem to have the least amount of experience. Engineers(54.5%), general contractors(68.6%), construction managers(42.9%), and owners(34.3%) are at the lowest echelon of knowledge. The proprietors seem to have the least knowledge and expertise with IPD, which is rather interesting. One possible explanation for the industry's sluggish acceptance might be that this group has the most say over the delivery method employed on their projects.
Firm size: The number of employees at a firm does not have a significant effect on IPD experience or on how informed respon- dents are about IPD. A total of seven tiers, from "under 50" to "2,000 or more" workers, were presented to survey takers. Every percentage falls within 3% of the total 45% of experienced respondents, with the exception of two groupings. The two exceptions are respondents who work for firms with 50–100 employees (38.8%) and firms with 500–1,000 em- ployees (34.6%), which do not appear to be of great significance, since an overall low deviation spans from the smallest to the largest firm sizes. With the exception of a slightly low percentage for firms with 50–100 employees (40%) and a high percentage for firms with 100–300 employees (75.8%), all other groups are within 2% of the overall 55% of informed respondents.
Firm revenue: When considering the respondent firms' size by the previous year's revenue, there appears to be slightly less ex- perience among the respondents that work for midsized firms (Fig. 4). 53.8% of respondents from firms with under $100,000 revenue have IPD experience and around 48.3% (average) from firms whose revenues were $10 million or greater. Of the groups whose revenues were between $100,000 and $10 million, only 36.5% (average) are experienced. Respondents from firms with revenue under $100,000 are substantially less informed about IPD than the rest. The remaining categories stay around the overall inexperienced informed respondents, with the exception of respondents who work for firms with $10 million to $100 million; 63.4% of this category is informed about IPD.
Experience with other project delivery methods: Fig. 5 shows the overall percentages of all respondents and the percentages from Groups 1 and 2, who have experience with different delivery methods. It is interesting to note that experience level with IPD increases with the level of experience with nontraditional delivery methods. Comparing informed respondents' experience (Group 2) on other project delivery methods shows similar results as the comparison with experienced respondents (Group 1). However, when all respondents are taken into account, the construction industry participants, in general, are less experienced with nontra- ditional project delivery methods when compared to the groups experienced with and informed about IPD.

Characteristics of IPD Projects

Survey participants with IPD experience were asked to consider a specific IPD project while answering a series of detailed questions

regarding IPD principles. The purpose of these questions is to verify whether or not these projects are actually being delivered in the same manner as described in prevalent literature on the topic and also to ascertain the attitudes and opinions on IPD from the professionals delivering the projects. IPD project characteristics and the benefits observed on IPD projects as well as the same three topics discussed above were covered in these questions: (1) multiparty agreements; (2) early involvement of all parties; and (3) shared risk and reward.

Multiparty Agreements

Background research revealed the following three contract models to be the most widely available IPD agreements for construction projects: (1) IFOA; (2) ConsensusDOCS 300; and (3) AIA's

Table 1. Involvement of Project Team Members during Stages of a Project

	Preliminary design (%)	Early design (%)	Design development (%)	Construction (%)	Closeout (%)	Facility management (%)
Owner	94.3	85.8	84.9	82.1	72.6	71.7
Architect	92.3	89.4	92.3	82.7	67.3	15.4
Engineers	71.0	86.9	91.6	85.0	60.7	19.6
General contractor	46.7	69.2	82.2	89.7	76.6	23.4
Subcontractors	17.1	41.9	72.4	89.5	67.6	22.6
Manufacturers/suppliers	11.8	41.2	74.5	87.3	48.0	23.5
Specialty consultants	43.1	69.6	83.3	79.4	46.1	28.4

transitional agreements or single purpose entity agreement. Based on the survey results (Fig. 6), AIA contracts are the most widely used at 28.7%, next is the IFOA at 15.7 and 5.6% have used the ConsensusDOCS 300 agreement, and 21.3% said they have used another IPD contract. These were modified traditional contractual agreements created internally or created by a client. The remaining 28.7% said they have not used a multiparty or IPD agreement, which suggests that their experience is on a project that employed some principles of IPD while using a traditional contract. The traditional "non-IPD" contracts listed by the respondents include the following: lease/lease back, design/build, guaranteed maximum price, and other standard contracts. Only slightly more than half of the respondents (51%) have actually used one of the three IPD contracts. Although the other half of the respondents (49%) claimed that they have experience with IPD, they implemented IPD concepts and tools with traditional or modified traditional contractual agreements.

When asked if any unforeseen contractual issues or problems arose during the course of the project, there were not major differences between the responses of three groups: respondents used an IPD contract; respondents used a modified traditional contract; and respondents used a traditional contract (Fig. 7). However, when responses from different disciplines analyzed, owners responded substantially different from the rest: 62.5% of the owners responded negatively and only 37.5% responded affirmatively (Fig. 8).

The following are some of the contractual issues raised by respondents: errors and omissions in contract documents; various interpretations due to unclear contract documents; lack of definition/structure for use of contingency; unclear BIM requirements; concerns regarding risk sharing and open-book accounting; owner's program not validated; and misunderstandings regarding the use of project contingency.

Early Involvement of All Parties

In order to gauge the level of engagement from each stakeholder, we asked experienced respondents to list the team members who were engaged in each step of their individual IPD project. In Table 1, you can see what proportion of projects each stakeholder is participating in at each stage. Since the general contractor, subcontractors, and manufacturers or suppliers are usually not engaged until the building phase on conventional projects, their participation throughout the design stages is of special significance to this research. You may compare the owner, architect, engineers, and specialty consultants based on their degrees of engagement, however. To establish a standard, we compare the outcomes of each stage to the recommendations made in the 2007 AIA California Council report "Integrated Project Delivery: A Working Definition" about the roles played by key stakeholders in both conventional and IPD projects. Preliminary Design: Typically, only the owner and architect are involved at this stage. At the beginning of this phase on IPD projects, there are only the two of them. However, the general contractor and specialist design consultants will also be involved later on. Specialty consultants were mentioned by 43.1% of respondents and general contractors by 46.7% during this part of the poll. Manufacturers and suppliers, as well as subcontractors, were not heavily involved. During the early stages of a conventional project's design, consultants in addition to the owner and architect are usually brought in. All stakeholders are welcome to attend this stage of an IPD project, as per AIA regulations. From the responses we have, it seems that specialist consultants made up 69.6% of the total, general contractors 69.2%, subcontractors 41.9%, and manufacturers and suppliers 41.2%.

In terms of design development, the AIA states that all stakeholders must now be physically present on IPD projects and must maintain some level of engagement throughout the duration of the project. Before agency approval and construction, the owner often collaborates with the architect and specialized consultants on the project's design. It is clear from the survey results that all parties involved are actively participating during this phase. Not only are general contractors (82.2%), subcontractors (72.4%), and manufacturers and suppliers (74.5%) actively involved, but so are the usual suspects: owners (84.9%), specialty consultants (83.3%), engineers (91.6%), and architects (92.3%). The survey question was designed to include the construction, close-out, and facility management stages of IPD projects so that it could be

shown that there is continuing multiparty engagement throughout these projects, even if this research primarily focuses on the early phases. Each partner is said to be participating in 80-90% of IPD projects throughout the construction phase, which shows the maximum total engagement. Consultants and suppliers are less active as the project nears completion, while the primary players are still reasonably involved. Lastly, in the facility management phase, it is evident that the owner is the main player, with all other stakeholders involved to a lesser extent (less than 30% of reported IPD projects included them).

Shared Risk and Reward

Experienced respondents were asked to indicate what compensa- tion method was used to incentivize collaboration on their specific IPD project. The following options were provided: 45.8% se- lected "based on value," which incentivizes the project team by offering a bonus linked to adding value to the project; 25.2% selected "incentive pool," which reserves a portion of the project team's fees into a pool that can increase or decrease based on various agreed upon criteria before being divided up and distrib- uted to the team; 17.8% selected "performance bonuses," which provides an award based on quality; 15.9% selected other; 13.1% selected "profit sharing," in which each party's profit is deter- mined collectively rather than individually; and 7.5% selected "innovation and outstanding performance," in which the team is awarded for hard work and creativity. The "other" category in- cluded lump sum bid, fixed fee, negotiated guaranteed maximum price, and various methods of shared savings. Owners relied on the other type of compensation methods (57.1%) including liq- uated damages and fixed price, followed by based on value and incentive pool type of compensation methods. When the results were filtered by IPD contracts only (ConcensusDOCS, AIA, and IFOA), based on value (52%) was followed by incentive pool (30%), profit sharing (20%), performance bonuses (18%), and innovation and outstanding performance (12%). The category other was used only by 6%.

Experienced respondents were also asked what kind of metrics developed to determine project performance. The majority said cost metrics were developed (82.4%), then schedule (81.5%), quality (60.2%), other (13.9%), and 5.6% were unsure. The met- rics provided in the other category included based on value added, safety, sustainability, and less field changes. Again, when only the respondents who used one of the three IPD contracts were ana- lyzed, the results were similar to all experienced respondents: cost (84.3%); schedule (78.4%); quality (60.8%); other (9.8%); and not sure (2%).

Benefits

According to AIA's "IPD Working Definition" (AIA California Council), construction phase is where the benefits of integrated model are realized. The following analysis outlines the various benefits that were observed by experienced respondents on a spe- cific IPD project. The most commonly observed benefits are fewer change orders (70.3%), cost savings (70.3%), and shorter schedule (69.4%). Fewer request for information is another sig- nificant benefit observed by 58.6% of respondents. Slightly less than half incorporated BIM-integrated operations (45.9%). Less construction administration (36%), more prefabricated materials (32.4%), and fewer injuries (21.6%) were also observed. Other benefits suggested by respondents include better quality, less stress and friction, more productivity, and more enjoyable projects.

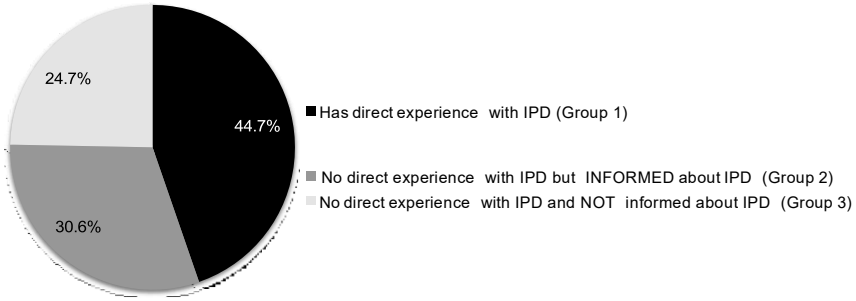

Fig. 2. IPD experience and awareness level of respondents

Projects

Experienced respondents were polled to get their opinions regard- ing project types and sizes that they believe would work well with IPD. The majority (59.6%) believed that IPD would work well with all types of projects. However, in terms of project size, most believe large projects (39.4%) and medium projects (30.3%) are better fits for IPD than smaller projects (9.2%).

Based on the answers, healthcare (32.1%), civic/government (31.2%), and industrial (30.3%) project types were found to be the top three appropriate projects for IPD implementation. Edu- cation (27.5%), commercial (27.5%), infrastructure (25.7%), and transportation (22.9%) projects followed closely. Residential (11.9%) and cultural (11.0%) projects were found the least appro- priate project types for IPD. 4.6% selected the other category and suggested sports stadiums/entertainment venues and large reme- diation projects to work well with IPD. These results infer that IPD is believed to work best on projects that are large, unique, or that require substantial coordination. It has been pointed out by the respondents

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 meth- odology.

associated with the delivery method; lack of client education around the topic; and unfitting client procedures/policies.

IPD and BIM

It is noted in the Introduction to this paper that IPD has materi- alized as a delivery method that could most effectively facilitate the use of BIM for construction projects. Due to the suggested efficiency of using BIM and IPD together, the survey included questions regarding respondent's BIM experience and opinions about BIM's relationship to IPD. Both groups showed a high level of experience on projects where BIM was used, though more so
with experienced respondents (76.2%) than informed respondents (62.2%). It is notable that experienced respondents overall have used a greater number of BIM's capabilities than informed re- spondents (Fig. 11). Both groups have an equally high level of experience using clash detection and visualization (rendering, 3D presentations, model walk thrus, etc.), but for all the other eight BIM capabilities listed, the experienced group responded 10–30%
higher than informed respondents. Figure below shows the per- centage of BIM capabilities used by both groups. Since it was a multiple-selection answer set, the percentages represent only a comparison to the total number of respondents that answered the question and not to the other tasks. When the results are analyzed, more conventional capabilities of BIM solutions, such as visual- ization, clash detection, and design collaboration, are used more widely than specialty-focused capabilities, such as digital fabrica- tion, environmental analysis, and facility management.

Further, 73.8% of experienced respondents consider them- selves or their companies to be "well trained and capable enough to use BIM effectively on an IPD project," while only 59% of informed respondents indicate such. This might have direct cor- relation with the amount of experience respondents have with BIM functions. Respondents were also asked if BIM is a prereq-
uisite for IPD (Fig. 12). Overall, respondents think that BIM is not a prerequisite for IPD: 43.5% of informed and 53.2% of ex-
perienced. 41.7% of informed and 36% of experienced respon- dents agreed that BIM is a prerequisite and 14.8% of informed and 10.8% of experienced respondents were unsure. The same trend was realized when owners are analyzed. 63% of the expe- rienced owners and 70% of the informed owners think that BIM is not a prerequisite for IPD. However, once more, the informed group of respondents thinks that BIM is a prerequisite for IPD more than the experienced group of respondents. General com- ments provided by the respondents at the end of the survey sup- port the agreement that BIM is not a prerequisite for IPD.

Industry Adoption

Respondents were asked if they foresee IPD someday becoming a widely embraced project delivery method in the United States. Experienced respondents (66.7%) believe more strongly that IPD will be used widely in the future. However, informed respondents also agree (58.3%). Almost one-third of the respondents of both
groups are still unsure (27% of experienced group and 31.5% of informed group). When owners are analyzed separately, two-thirds of the owners with IPD experience and half of the informed
owners believe that IPD will become a widely embraced project delivery method in the future.

Respondents were also asked to organize a list of potential obstacles in order of their hindrance to the widespread adoption of IPD. Both groups indicated that business risk and fear of change were the biggest obstacles. Lack of IPD awareness and lack of appropriate legal structure were next on the list for both groups. The obstacles most frequently listed last for both groups were limitations of technology and lack of industry-wide stan- dardization. Other obstacles offered by the respondents are lack of trust and greed by involved parties, cultural barriers within the industry, and lack of appropriate insurance products. Responses reflect a general attitude of falling back on tradition and an un- willingness to try something new because "we have done it this way for many years." However, when respondents in the in- formed group were asked if they would be interested in working on a project that used IPD as a delivery method, 97% said yes
(99% when owners are filtered out). However, only 71% of the informed owners indicated that they would be willing to work on a project that used IPD as a delivery method. This demonstrates
that respondents who are informed believe in the concept of IPD and are very much willing to work on an IPD project.

Recommendations for Education and Future Research

While this survey represents a first step toward understanding construction industry experience and attitudes regarding IPD, there are several other avenues that should be pursued. As the construction industry shifts toward adopting IPD, the education system should take a more collaborative approach in teaching and research. Degree programs in civil engineering and CM need to address new procedural and technological concepts in the under- graduate programs, in more sophisticated master level courses, and as prime research objectives for doctoral students.

Further investigation is needed for several research questions such as how to best improve liability insurance products and cur- rent contractual models and if and when the design/build delivery method is truly a better methodology than IPD. There is also a need for a study on IPD's return on investment. Introducing IPD will be difficult unless there is overwhelming evidence that it will improve profits, reduce operating cost, and save money in the long run. One of the greatest difficulties is defining the risks, responsibilities, expectations, project goals, and liabilities when negotiating IPD contracts. Some of these issues would be better examined in detailed case studies with extensive interviews and concurrent project documentation. Collecting best practice IPD case studies would help professionals who are unfamiliar with IPD to get assurance of how the profits have played out both on successful and unsuccessful project examples. Finally,

the survey or versions of the survey could be distributed at future points in time to compare the progression of change as the industry becomes more proficient and experienced with IPD.

Conclusions

The United States construction sector has only just begun to adopt IPD. There has to be an emphasis on IPD education since, while some professionals have worked on IPD or projects similar to it, the majority either lack direct experience with IPD or are unfamiliar with its ideas. There seems to be an openness for that additional instruction, given the widespread belief that construction projects are delivered inefficiently and the high degree of interest in IPD.
The importance of trust, respect, and excellent working relations in ensuring the success of IPD programs was highlighted by respondents. Many people think these relational variables are crucial for IPD to be successful, and they think monetary incentives aren't the best way to encourage collaboration. Furthermore, in order to foster an atmosphere of teamwork, respondents believe that strong leadership is necessary. Conversely, respondents were quite unsure about the feasibility of establishing such an atmosphere, according to the poll. Compared to more conventional distribution techniques, most people would rather have IPD. Concerns about open-book accounting, liability insurance, and risk and reward sharing mean that industry-specific contracts for IPD are underutilized. While some have seen advantages, most are waiting for additional proof before completely embracing IPD as a project delivery approach.
Finally, the survey responses show that experience with IPD does not significantly affect the attitudes of industry professionals toward this delivery method. Respondents with greater experience were somewhat more positive on the variety of delivery techniques that may be used with IPD. Concerns about utilizing IPD and success factors were almost same in replies. Using building information modeling (BIM) was the one area where the two groups differed significantly. Those who had worked with IPD had greater knowledge with building information modeling (BIM) and had made better use of its features. While this seems to suggest that BIM is being used on IPD projects more than other types of projects and to a higher level of sophis- tication, many respondents emphasized that BIM or advanced in- formation technology applications are not a prerequisite for IPD. Additionally, individuals with greater experience were more likely to have a positive outlook on the ultimate widespread adoption of IPD in the US. Nonetheless, extensive implementation of IPD in the business is still hindered by cultural, procedural, and organizational hurdles.

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