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Transitioning to Integrated Project Delivery: Potential barriers and lessons learned

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Abstract

Research Question: How do architecture, engineering, and construction (AEC) professionals overcome the most prevalent barriers of implementing IPD?

Purpose: To investigate how successful IPD projects overcome legal, cultural, financial, and technological barriers in an effort to achieve wider adoption of IPD by the industry and to provide lessons learned to industry professionals interested in implementing IPD as a delivery method.

Research Design: A brief review of the current situation of the AEC industry; semi-structured interviews with leading AEC professionals in nine IPD projects.

Findings: The study finds that successful IPD projects are achieved through proper selection and involvement of all main players as well as these main players achieving trust in each other. Training, procurement ability, and collaborative technology are also among the key factors for a successful transition to IPD.

Limitations/Implications: Eight out of nine cases are from the state of California.

Value for Practitioners: This paper highlights common barriers that currently exist in implementing IPD and provides lessons learned to practitioners in order to overcome these barriers.

Keywords: integrated project delivery (IPD), barriers, relational contracts, insurance, compensation, collaboration, integration

Paper type: Full paper

Introduction

Traditionally, the architecture, engineering, and construction (AEC) industry employs standard project delivery methods like design-build, design-bid-build, and construction manager at risk. However, many industry professionals are dissatisfied with project outcomes and argue that projects often run over-schedule, over-budget, and are of low quality (Lichtig 2006). The AEC industry is fragmented, inefficient, and adversarial because

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each team is responsible for its own silo of work and attempts to maximize their individual profit in the area of their own expertise. (Pelberg 2009; Lichtig 2006**).** As a new project delivery method, integrated project delivery (IPD) attempts to address the problems of waste, inefficiency, and adversarial relations in the AEC industry, and to increase the likelihood of project success (Autodesk White Paper 2008; DeBernard 2008; Lichtig 2006).

IPD is a highly collaborative process that integrates the expertise of project teams during the early project stages. Experts from every discipline are present at the project's inception to ensure that overall design decisions meet the needs of all involved entities. Although several professional organizations support the advancement of IPD (AIA 2007; AIA California Council 2008; AGC 2009), and prior research efforts demonstrated its benefits and challenges (Matthews and Howell 2005; Hellmund et al. 2008; Cohen 2010; Becerik-Gerber and Kent 2010), the number of projects using IPD remains relatively small (Kent and Becerik-Gerber 2010; Sive 2009). Researchers also compiled empirical data assessing AEC industry attitudes and experience levels regarding IPD (Kent and Becerik-Geber 2010) and identified barriers impeding its widespread adoption; these barriers have caused the infancy period of IPD to last longer than expected (Kent and Becerik-Gerber 2010; Cohen 2010). Although much has been written on IPD and its application, few guidelines exist that outline the factors that contribute to the success of multidisciplinary IPD projects.

This paper identifies the best IPD practices that help overcome barriers related to IPD implementation in an effort to achieve widespread adoption by the industry. In order to facilitate a faster transition to IPD, it is necessary to overcome the most prevalent barriers to its implementation (Sive 2009). The paper builds on the identification of four barriers impeding the industry-wide adoption of IPD by Kent and Becerik-Gerber (2010) and Cohen (2010): (1) lack of appropriate legal structure, including allocation of risks and insurance products, (2) cultural barriers within the industry, (3) allocation of financial incentives, and (4) technology limitations.

Differences between ipd and traditional delivery methods

The American Institute of Architects (AIA 2007) defines IPD as *"a project delivery approach that integrates people, systems, business structures, and practices into 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."* IPD is a new method by which construction projects are organized and executed, and the following characteristics differentiate IPD from traditional delivery methods:

- A multi-party contract;
- Early involvement of key participants;
- Collaborative decision making and control;
- Shared risks and rewards;
- Liability waivers among key participants;
- Jointly developed project goals.

All the above characteristics must be incorporated in a project for IPD to be realized in its purest form (Sive 2009). Many IPD projects in the U.S. do not employ all of these characteristics; instead, they sample some of the IPD characteristics to achieve higher efficiency. There are fundamental differences between traditional delivery methods and

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IPD; the main differences are in terms of contracts, project team relationships, and compensation structures.

Contracts

The current contractual structure causes disputes and inefficiencies because it encourages each party to concern itself with its own interests rather than the interests of the project as a whole (Martin and Songer 2004). Some of the systematic problems with traditional contracts include restraining good ideas, limiting cooperation and innovation, inhibiting coordination, and forcing the team members to optimize their own silos (Matthews and Howell 2005).

Macneil and Williamson define two broad classes of contracts: transactional and relational. Transactional contracts are defined by exchange of goods and services; on the other hand, relational contracts resemble small, nuclear societies, with their own internal system of evolving norms (Williamson 1979).

IPD contracts are known as "relational" contracts because consideration is given to the process, not just to the end product (Pelberg 2009). Macneil suggested that when parties expect to work together again in future, they approach and manage their current transaction with such a future relationship in mind (1975). Below are the characteristics of most widely used relational contracts for IPD projects:

- **AIA C195 (Single-Purpose Entity) -** This contractual model embraces the principles of IPD by creating a limited liability company (LLC) whose sole purpose is to plan, design, and construct the project.[3]
- **AIA C191 (Single Multi-Party Agreement) -** AIA Document C191–2009 is a standard multi-party agreement through which the owner, architect, contractor, and other key project participants execute a single agreement for the design, construction, and commissioning of a project.[4]
- **ConsensusDocs 300 (TRI-PARTY Agreement) -** This agreement calls for the owner, architect, and contractor to enter into a tri-party agreement and attempts to align the interests of parties through a collaborative process in the design and construction of the project by sharing certain risks and rewards.[5]
- **Integrated Form of Agreement (IFOA) (Single Multi-Party Agreement) -** IFOA binds all the parties involved into a single agreement and requires them to share risks and rewards. Its main purpose is to facilitate integrated practice through collaborative design, construction and commissioning of a project.[6]

Project team relationships

IPD principles rely on encouraging transparency, open communication, honesty and collaboration among the main stakeholders (Pelberg 2009; AIA 2007). Mutual respect and trust is the single most important principle of IPD (AIA 2007). Trust is gained through relationships and commitment; when this kind of trust is present, an individual accepts risks knowing that the intention of others is mutually positive (Martin and Songer 2004**).**

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3 http://www.aiabookstore.com/aia-documents/aia-documents-c-series/c195-2008-standard-form-single-purpose-entity-agreement-ipd.html 29 Dec 10

4 http://www.aia.org/aiaucmp/groups/aia/documents/pdf/aiab081563.pdf 29 Dec 10

5 http://consensusdocs.org/catalog/300-series/ 29 Dec 10

6 http://www.thechangebusiness.co.uk/TCB/ifoa.html 29 Dec 10

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Briscoe and Dainty's study of supply chain integration in construction found that the lack of trust among the different parties inhibited project teams from achieving the collaboration necessary for an integrated project (Briscoe and Dainty 2005).

The current extent of litigation in the AEC industry illustrates the high level of distrust among project members (Martin and Songer 2004). The Briscoe and Dainty's (2005) study also showed that collaboration on integrated projects required an environment of mutual respect and trust under which teams could share information and knowledge during the decision-making process.

Compensation structures

IPD's compensation structure follows the project alliancing model, with the goal of stimulating efficiency and the alignment of interests for the benefit of the project as a whole (ADTF 2006). In this model, project participants are compensated on a cost-plus basis where the owner guarantees the direct cost, but a portion of the profit and participants' bonuses are dependent on the project outcome (AIA 2007).

Risk management depends on the project outcome and is a challenging aspect of traditional projects (Jaafari 2001). In IPD, the overall risk remains the same (AIA 2007), but IPD leads to a more equitable approach to risk management and a less risky project overall by tying project risk and uncertainty to the outcome and collectively managing it (Darrington et al. 2009). In return, IPD projects compensate team members by providing rewards that are tied to achieving project results (AIA 2007). By aligning the goals of parties around collective project success and making each party accountable for the behavior of others, project teams gain more control of the overall process and better mitigate the overall risk (Cohen 2010).

Research methodology

A qualitative investigation through multiple industry cases was used to answer the research question: what are the barriers and challenges to implement IPD to its full capacity? The interview questions were designed to gather information on existing IPD practices and how each case overcame identified barriers. The questions were developed after an extensive three months long literature review. Interview questions were categorized according to four barriers identified in the literature: legal, cultural, financial, and technological.

Researchers recommend examining multiple cases to manage the validity of the constructs identified (Eisenhardt 1991). Due to the limited number of IPD projects that have been completed or are currently underway, only a qualitative investigation of IPD cases was possible. Interviewees were narrowed down and contacted from a list of 415 participants from the 2009 IPD survey (Kent and Becerik-Gerber 2010) and referrals from the AEC industry.

Participants were considered eligible if they reported experience with IPD and were part of the upper echelon of their firm, that is, company owners, executive managers, and project managers. Participants were contacted by email. Although not all project members from each of the cases were interviewed, the researchers were assured that the interviewees have sufficient information to answer all questions related to the project. Of the firms investigated in this project, three interviewees were from construction firms, two interviewees were from architectural firms, two interviewees were owner/owner's

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representatives, and two interviewees were from integrated suppliers providing design and construction services. Formally structured interviews were conducted via telephone and in person; the interviews lasted about an hour each**.** The interviews were recorded and then analyzed to indentify how successful IPD projects had overcome the most prevalent barriers.

Coding of key terms drawn from a literature review allowed for identification of common themes. Headings drawn from this coding system collected the attributes deemed to be most important for the successful implementation of an IPD project. The results of the nine IPD cases are presented below.

Summary of ipd industry cases

For this study, the authors adopted the following definition set forth in AIA California Council (2007): "at minimum, an integrated project includes tight collaboration between the owner, architect/engineer, and builders that are ultimately responsible for construction of the project, from early design through project handover."

Table 1: The extent to which each case embodied IPD characteristics

Case no.	Early involvement	Shared risk/reward	Multi-party contract	Collaborative decision making	Liability waivers	Jointly developed goals
1	◆			◆		
2	◆	◆	◆	◆		◆
3	◆	◆	◆	◆		◆
4	◆	◆	◆	◆	◆	
5	◆			◆		
6				◆		
7	◆					
8	◆	◆	◆			◆
9	◆	◆	◆	◆		◆

Case 1 - Los Padrinos Juvenile Hall Expansion

The Los Padrinos Juvenile Hall Expansion project was delivered in 2005 and included two 37,000 sq ft, $29 million additions, each of which consisted of new 120-bed dormitories and a parking structure addition for 85 cars. The design-build firm acted as the architect of record and also provided construction services (25%) in a joint venture along with a contracting firm (75%). This project faced what is commonly known as a "sunsetting" funds problem, in which money would be returned to the state if the project was not completed by a given deadline. In order to combat the additional pressure, the owner brought in the designers and contractors early and set the project goals. In addition, an integrated services team with the participation of an owner representative was formed to make sure the project progressed properly and decisions were made within this period. The main participants were paid on a cost-plus basis, with no shared risk or reward.

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Case 2 - Pomona Hospital

The Pomona Hospital project is a three-story, 55,000 sq ft building and a 5-acre site development project. This project started in 2008 and, at the time of this paper, is currently in progress. The project involves a large seismic upgrade and retrofit of the hospital campus. As part of the project, the hospital is also going through a lean process internally to determine the facilities the medical staff needs which are not "critical care", are permitted by Office of Statewide Health Planning and Development (OSHPD), and can be housed in the less expensive new space . The design-build firm proposed to move these facilities outside of the existing hospital to the new, less expensive 55,000 sq ft space, providing the owner the needed space while the seismic upgrade and retrofitting of the existing hospital take place. The owner selected the design-build firm primarily based on the owner's long standing working history with this design-build firm. The design-build firm competitively selected the mechanical and electrical subcontractors as part of their IPD team. As they had both design and construction capabilities in-house, integrated practice was not new to the firm, who convinced the owner to implement IPD through AIA 195-295 contracts in June 2008. The main participants are compensated on a cost-plus-fee basis, with a shared risk and reward scheme. This allows participants to share savings and any contingency fees remaining, as well as holding the possibility of increased compensation based on quality of performance.

Case 3 - Sutter Medical Center Castro Valley

The $320 million project involves construction of a new, state-of-the-art hospital on the Eden Medical Center campus in Castro Valley, as well as campus improvements including additional parking and the demolition of the old hospital when the new hospital is completed. The project is fully funded by the owner, Sutter Health**.** The contracting firms along with all ten of the other key participants were on board early on in the project and signed an integrated form of agreement (IFOA). Additionally, five other parties were involved early but were not parties to the IFOA. The main parties released each other from liability with a "no sue clause" agreement, except in the event of gross negligence.[7] The main parties worked collaboratively to develop the estimated maximum price (EMP), established after a 6-month validation effort, approximately 10-12 months before the project broke ground. Currently, the project is in the construction phase. Project participants are compensated on a cost–plus-fee basis and there is a shared risk and reward scheme, where the parties to the IFOA would share the savings and the overruns, with a possibility of increased savings by meeting quality criteria specified by the owner.

Case 4 - Autodesk One Market

The Autodesk One Market project involved a commercial interior renovation of about 40,000 sq ft with a roughly $10 million budget and an aggressive 9.5-month design and construction schedule. The project's main team included an owner, a general contractor, and two architects. These participants signed a relational four-party integrated project delivery agreement (IPDA), and all parties were on board early on when design started. The main parties released each other from liability and were compensated on a cost basis

[7] The IFOA contract does not have broad waiver forms, as this would potentially nullify the ability to obtain insurance coverage for the project. Instead, the contract calls for "Indemnity Clauses," which are essentially an agreement among project members not to sue each other and to take care of each other as if they were one team.

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without a maximum all the way through the life of the project. The project's risks and rewards were shared by all parties through the incentive compensation layer (ICL), in which the direct costs of construction and project overhead are guaranteed to each party. The profits are placed in a common pool and are distributed based on the project's success. The success of this project was determined by the following criteria: functionality, aesthetics, materials, workmanship, and sustainability. The ICL could increase or decrease based on the project outcome. At the end of the project, an independent reviewer was hired to review the space based on the requirements of the program and compare them against a benchmark of three other projects with similar scopes and purposes. The project achieved the design goals, and the ICL was increased by twenty percent. This award was then divided among the team members proportionally based on each party's profit and the overhead percentage placed in the pool.

Case 5 - Brigham Young University (BYU)

This project involves design and construction of a $15 million university building located on the BYU campus. The owner's organization is set up in a way that enables them to provide planning, design, construction, space management, and maintenance services. For this project, the pre-planning groups and the third-party contractor were in charge of the estimate. Pre-planning groups were also in charge of establishing project goals and aligning them with the project mission as well as approving the scope, budget, and programming. Upon the approval of the scope and budget, the rest of the IPD team was then invited onto the project. The IPD team was comprised of the architect, contractors, and the owner representatives. The core team (executive group) was comprised of representatives from planning, design, and space management organizations within BYU. This core team was present and met weekly as the project progressed. Moreover, other project team members (architects, contractors, subcontractors) were encouraged to attend the core group meetings. The project adopted traditional AIA documents, which it modified into its own IPD contract. Currently, the project is in its design schedule phase.

Case 6 - Grant Joint Union High School

The Grant Joint Union High School project involved construction of a new $150 million high school campus to meet the needs of the growing population in the suburbs of Sacramento. The construction of the project was completed in 2005. Project participants were selected in accordance with a California code which involves a two-step process. First, the teams submitted a request for qualification (RFQ), after which the pre-qualified teams were required to submit a request for proposal (RFP). There were three criteria for selection of the team: past performance based on previous California school experience, previous design-build experience, and finally previous projects, where contractors and architects had worked together. The project adopted a DBIA (Design-Build Institute of America) contract in an integrated fashion. As the design progressed, the owner maintained close involvement and attended weekly meetings with the design-build entity. In addition, key subcontractors were included as part of the RFP and were involved once the design started. The project participants were compensated via a lump-sum agreement.

Case 7 - West Los Angeles College

The project involves design and construction of two 38,000 sq ft buildings: the performing arts center and the learning center for the LA college district in West Los

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Angeles College. Both of the projects were projected to be LEED Gold-certified and were design-build projects, which the owner (the college district) required to be executed through IPD. The design firm developed the contract documents. The project was under extreme time pressure from the start. The design firm needed to complete two-design development sets in 5 weeks. By employing IPD, they were able to finish the job by the specified deadline. The designers were compensated based on a fee, and the main incentive for the team was to finish the project on time. Another firm is completing the construction documents, and construction was set to begin in Fall 2010.

Case 8 - Cathedral Hill Hospital (CHH)

The CHH project involves design and construction of a 1.3 million sq ft medical facility located in an urban area of San Francisco. The owner, California Pacific Medical Center (CPMC), an affiliate of Sutter Health, selected the architect and general contractor based on their past experience and familiarity with lean principles. The construction value is estimated at about $1 billion. The project began in 2007; construction is expected to be completed by 2015. The project has adopted an IFOA three-party agreement. The main subcontractor also signed what is called a joining agreement by acknowledging their commitment to and understanding of IFOA and IPD method. The major parties were compensated via cost-plus-fee and were reimbursed for their time and materials. The shared risk/reward pool involved pooling of 25% of everyone's fee, including the owner, into a risk pool. The risk pool will be used to cover cost overruns if the final cost is above the estimated maximum price (EMP). If the final cost is below the EMP, the risk pool will be distributed among the members.

Case 9 - Sutter Medical Center Sacramento (SMCS)

The SMCS project involves the renovation of the Sutter General Hospital in Sacramento and construction of a new power plant, medical office building, and women and children's center. The decision to employ IPD was driven by Sutter Health. The project is about $724 million, of which $450 million is for construction. The current contracting firm took over from another contracting firm, which had been working on the project since 2003. The SMCS project is scheduled to end in 2011. The main teams are part of an IFOA multi-party agreement. Participants are compensated based on cost plus fee. The "pain-gain" mechanism is employed to give the participants the incentive to drive down the overall cost of the project. At the end of the project, project savings along with added bonuses are shared among the participants, including the owner.

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Table 2: Detailed information of the industry cases

Case no.	budget ($m)	Contract	Risk/reward	Compensation structure	Bonding required?	duration (years)
1	$29	Modified DBIA	N/A	GMP	Yes	1
2	$33	AIA 195-295	Sharing saving/overruns	GMP	Yes	5
3	$320	IFOA	Sharing saving/overruns	EMP	No	5
4	$10	IPDA	Profit pooling	GMP	No	<1
5	$15	Modified AIA	N/A	GMP	Yes	2
6	$150	DBIA	N/A	Lump sum	Yes	2
7	N/A	DBIA	N/A	Fixed fee	N/A	<1
8	$1700	IFOA	Profit pooling	EMP	No	8
9	$724	IFOA	Sharing saving/overruns	EMP	No	8

Ways to overcome barriers in implementing ipd

As a new delivery method, IPD presents novel challenges for the owner, designer, and the contracting team, including legal, financial, cultural, and technological barriers. The following sections report how each of the cases was able to overcome these major four barriers.

Cultural barriers

Cultural barriers refer to the unwillingness of the industry to vary from its traditional methods, as many AEC firms are accustomed to their own narrow leadership. The challenge is overcoming the inertia and changing the mindset built on the traditional hierarchy (AIA California Council 2008; Lichtig 2006).

Integrating Project Personnel

In traditional projects, a team member might be brought into the project late in the design process or during construction. This causes inefficiencies as the newcomers are usually not well coordinated with the rest of the team. Even though collaboration between the owner, architect, and the contractor takes place for all projects investigated, reaping the benefits of IPD was found only to be possible when the subcontractors were brought into the design and construction process as early as possible.

Involving subcontractors in the design process helped case 2 to reduce the cost of structural steel as the subcontractor designed a new detail in the design of slip joints that would work with moment frames. In case 6, the design-build code required the mechanical and electrical subcontractors to be identified by the design-build firm as part of the RFP. The contractor brought their subcontractors on board as the design progressed.

A trend across the cases indicates that most teams are prone to choosing integrated subcontractors that have both engineering and trade services in-house. Subcontractors in cases 1, 2, and 4 all had the design and installation in-house.

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Cases 3, 8, and 9 called their subcontractors "trade partners", treating them as partners on their projects. Contrasting strategies emerged for involving subcontractors on the IPD teams. In cases 3 and 9, all main subcontractors were the parties to the IFOA agreement as they signed a multi-party agreement along with the owner, general contractor, and the architect. In case 8, subcontractors signed a separate "Joining Agreement" promising their collaboration and commitment to IPD in addition to the three-party contracts signed by the owner, architect, and general contractor.

Cases 2, 3, 4, 7, 8, and 9 took a more proactive integrated approach as the whole project team was located in the same building and the design was integrated into a singular BIM model, allowing for stronger collaboration and sharing of information.

IPD Training

IPD training played an important role on most of the projects investigated and proved to be a crucial element in overcoming cultural barriers. The training was achieved at two levels, at the organizational and at the project level. Training at the organizational level involved general training regarding IPD and was done as part of a company's voluntary transition toward IPD. Four out of nine cases had a program, in which they trained their employees in IPD.

Eighty percent of the employees of the design-build firm in cases 1 and 2 were enrolled in a one-day course about IPD methodology. The architectural firm in case 4 also took the initiative to train their employees in IPD methodology before entering into any projects; the organization has taken an initiative to have certain people trained and certified in IPD.

In case 5, the owner asked volunteers to be involved with their integrated project, which helped them identify those who needed training. This type of exercise allowed the firms to recognize those who could not fit into the IPD environment. These firms placed project participants on projects accordingly. Training at an organizational level was an important factor for overcoming cultural barriers as it helped firms to identify individuals that fit to the collaborative nature of IPD.

Project-level training refers to a series of activities completed early on or as the project progressed. These activities were completed at the discretion of the owner and after teams were put together.

In cases 1, 2, and 9, by using internal and external resources, the owner established a continuous learning plan throughout the course of the project. In cases 1 and 2, continuous training was carried out in three stages:

- project teams attended a meeting before they were awarded the project and before the start of design. In these meetings, a consultant was hired to train the team and encourage project participants to set goals and expectations for the project.
- the project participants also met throughout the design process and halfway through construction to ensure all expectations were met.
- there was a meeting at the end of the job to discuss the lessons learned from the project.

In cases 3, 4, 7, 8, and 9, all project participants, including the subcontractors, were present early on and were instructed concerning the project's goal and set-up. Training of

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those members ensured that all members were comfortable with the methodology and definitively committed to the project.

Case 8 reported a series of Study-Action Team™ activities designated for familiarizing the teams' understanding of fundamental concepts of integrated design and construction. Case 8 also took training the project members a step further by contractually requiring project members to read books about IPD methodology.

In addition, there were seminar-type events in cases 3, 4, 8, and 9. In these events, organizations supporting IPD, individuals experienced with IPD, and companies pursuing IPD gathered together to share educational materials and their learning experiences in the form of workshops.

Trust-building Activities and Tools

This theme emerged across several cases and allowed project teams to overcome cultural barriers by building confidence toward each other. The following factors helped project teams develop mutual respect and trust:

- collaboration at the inception of the project;
- coordination of communication between team members, including open conversations between and within groups;
- shared team confidence based on the capabilities of individual team members; and
- openness, honesty, and transparency between all team members.

All of these items together develop trust among the teams. The cases studied demonstrate that trust comes in two ways: preexisting trust and forced trust.

Preexisting trust was observed across cases where the participants had long and successful past working relationships. In both public and private projects, having a good past working relationship between the owner and other stakeholders was one the factors taken into account during the owner's selection of the team. In case 2, the owner selected the design-build team based on their past 10-year working relationship. Similarly, in cases 3 and 4, the owner and the contracting firm had collaborated on other projects in the past. In case 6, a past relationship between the architect and the contractor was one of the three criteria specified by the California code and was taken in consideration in the RFP.

Where preexisting trust did not exist, a set of general tools and activities facilitated collaboration and allowed the project team members to acquire trust intentionally. Having team members collaborate and spend time together was mentioned by many of the cases as a requirement to achieve mutual respect and trust.

In case 1, trust was achieved through forced communication. The design-build project required the team members to meet face-to-face rather than communicating via email. In case 7, strong communication helped the team develop confidence as they became aware of each other's capabilities. In addition, the use of the lean construction concepts "Target Value Design" (TVD) and Last Planner® System (LPS) proved to facilitate collaboration, communication, and trust among the project participants.

In case 3, IPD teams collaborated extensively and underwent a 6-month validation effort to develop the TVD. Likewise, in cases 2, 8, and 9, the contractors, subcontractors, and architects underwent a similar validation study to produce a mutually agreeable

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project costs. Validation study allowed contractors, architects, engineers, and subcontractors to get together in a *Big Room*.

The Big Room (or co-locating) concept allowed the teams in cases 3, 6, 8, and 9 to constantly interact, communicate, and give each other feedback. Project teams were able to test their ideas and get the real-time estimates on the same day, which not only facilitated collaboration but also helped with the decision-making process.

Financial barriers

Financial barriers refer to the challenge of selecting compensation and incentive structures commensurate to the unique characteristics of the project and its participants (Cohen 2010).

IPD Compensation Structure

Traditional contract structures tend to inhibit collaboration by only providing incentives for each individual firm. The review of industry cases (table 2) revealed that most IPD projects follow guaranteed maximum price (GMP) or estimated maximum price (EMP) for the compensation on their projects. EMP is similar to GMP in the sense that parties involved are paid based on a cost plus a fee with a difference that in EMP the owner will share the costs in excess of the estimated amount (Darrington & Lichtig 2010). Although the use of EMP allows the owner to take on the risk, otherwise assumed by the general contractor, and helps designers and contractors to focus on the project's overall goals (Darrington et al. 2009), there seem to be limitations to its use.

In case 2, the project team had to establish GMP after six months of design development as the owner needed financing on their project in order to obtain funding and bond the project. In addition, two different approaches emerged concerning sharing risk and reward: sharing cost savings and overruns, and profit pooling.

Sharing cost savings and overruns

Sharing cost saving and overruns refers to when project team members collaboratively agree upon a target budget and share the savings realized on the project. The cost sharing/overrun scheme was more prevalent when the majority of the subcontractors participated in the risk/reward and bonus program.

In case 2, the design-build firm provided a target cost and established the GMP after an extensive validation period. The contingency funds were held by the core team and were accounted for in the target cost of the project. At the end of the project, the savings realized from the project along with the remaining contingency funds were added to the savings and distributed among the members based on the risk each party has taken on in the project. There is a discretionary fund from anything that is left over, which is set aside to award additional bonuses to the teams who met the quality criteria set by the project.

Likewise, in case 3, eleven parties to the IFOA contract along with a few other key subcontractors worked collaboratively to establish the TVD. TVD requires project value, cost, schedule, and constructability to be the basic components of design criteria (Darrington and Lichtig 2010). As part of the contract, the IFOA calls for the team to develop a TVD in which the project members provide the best possible design that can be constructed for the target cost. The EMP was established after the validation study. There are two types of contingency funds, one under the discretion of the owner set aside in the

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event of force majeure, and the other one being the project team contingency. The allocation of risks and rewards is based on the percentage of the project each participant has at risk. If the project is completed under the established EMP, 50% of the savings realized go back to the owner and the remaining 50% is distributed to other project members according to the amount of risk each party took on.

Case 9 uses a similar savings model, where project participants share savings if the project finishes below the target price and bonuses are distributed to the teams if they meet the quality, schedule, and cost criteria of the project. Similar to cases 2 and 3, in case 9, the contingency fund is also held by the project and not by the individual project participants.

Profit pooling

Profit pooling involves project teams to place a percentage of their fee or profit in a pool and withdrawing it at the project conclusion, with a possibility of increased bonuses if the specified targets are met.

In case 4, the IPDA contract called for the creation of incentive compensation layers (ICL) for the sharing of risks and rewards as well as additional bonuses to the project. The parties to the contract estimated their cost for the given project duration and placed 100% of their added profit in the ICL pool. Additional design bonuses were awarded to project teams as the ICL pool was expanded, based on the meeting of the target design. At the end, the ICL pool was distributed according to the profit each participant had placed in the pool.

Similar to case 3 and 9, case 8 involved the participation of main project participants in developing the TVD. However, in case 8, project members along with the owner put 25% of their fee in a risk pool, which is used to cover cost overruns during the project. The shared risk pool in case 8 is to be paid to the IPD team members, if the project is less than or equal to the EMP. Moreover, a system has been devised for awarding bonuses to the teams who are able to meet the quality, schedule, and cost of their project.

Legal barriers

Legal barriers refer to issues of liability and insurance. To allow for increased collaboration, some IPD contracts eliminate or reduce the abilities of parties to sue one another. Current insurance products are designed to assign liability to each participant and the liability issue makes the insurance and bonding requirement more complicated (Cohen 2010; Sive 2009; Pelberg 2009).

Insurance, Bonding, and Legal Limitations

While the biggest fear for industry professionals concerning adopting IPD is the issue of insurance and risk allocation (Kent and Becerik-Gerber 2010), all multi-party agreement projects investigated were able to overcome the legal barriers by selecting contracts that fit within traditional insurance products, or were able purchase an insurance product that satisfied their project needs.

Contrasting strategies emerged concerning managing risk and selecting proper insurance products on IPD projects. As an already integrated supplier, the design-build firm involved in cases 1 and 2 had an agreement with an insurance company and used comprehensive general liability (CGL) insurance on most of their IPD project. This type of insurance covers their professional liability during both design and construction stages.

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In case 2, since the firm is in charge of both design and construction, an additional professional "project-specific professional liability" was purchased at the project's expense to cover all project participants.

In case 3, the general contractor firm purchased a contractor-controlled insurance program (CCIP), which covers all parties involved including the owner, contractor, and subcontractors for builder's risk, worker's compensation, general liability, excess liability, pollution, auto, etc. However, this type of insurance does not provide any professional liability insurance for errors and omissions, for which insurance had to be purchased separately.

Case 4 was the only project in which all four of the parties waived all claims against each other except those arising from fraud and gross negligence and all project participants used their own traditional insurance. Similarly, in case 9, the contract allowed the team to maintain their own traditional insurance; moreover, fully wrapped general liability coverage was placed to cover third party bodily injury and property insurance. To cope with the third-party claims, all Sutter Health projects using the IFOA contract reported placing an *indemnification clause*, in which project members all agree not to sue each other except in the event of gross negligence.

In cases 1, 2, 5, and 6, bonding was required as part of the owner's request and was included as part of the contract. None of the cases that required bonding were able to have any sort of liability indemnification or waivers on their project. Although surety bonding was not seen as a legal impediment preventing IPD's initiation in the context of the cases studied, sureties have yet to learn how to distinguish between design and construction responsibility. As for IPD project in case 2, in which the owner required bonding (table 2), the best possible solution was for the design-build firm to bond the project as a whole. The rationale for not requiring bonding was that in projects, where project teams were selected based upon qualification and were part of a multi-party agreement, the owner saw no need to bond the entire project. All of the public project cases in this study required bonding as part of their contract.

IPD in the Public Sector

In the public sector, state and local laws governing procurement inhibit early collaboration between the owner, architect, and contractors. Laws in California do not allow an owner to enter into a multi-party agreement with the architect and contractor as signatory parties in public projects. In addition, there is no law allowing for the best value selection of an IPD team in California; IPD's value selection criteria can only be achieved through a public law designated for design-build delivery.

In cases 1, 6, and 7, the participants delivered their projects using design-build contracts while still using the two most important features of an IPD project: early involvement of key participants and collaborative decision-making and control.

In case 1, the architect, contractor, and the owner were present and collaborated from the early stages until the end of the project. This enabled the team to finish the project two months ahead of schedule.

In case 7, the project chose design-build but was required by the owner to be IPD.

In case 6, the owner's involvement began after the procurement period ended. Therefore, the owner was involved in the design process onward.

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Negotiating relational contracts in a public entity is much harder because a system of check and balances for the taxpayers' money is needed; the perception remains strong that competitive bidding is needed to ensure fairness in selection. Hence, the role of state and local law governing procurement deserves more attention to achieve successful IPD implementations.

Technological barriers

Technological barriers refer to the legal challenges of ownership, liability and interoperability concerns in the integrated use of technology to achieve collaboration on IPD (Kent and Becerik-Gerber 2010 ; Hess 2009; Ashcraft 2008).

Integration

Although technology was not an issue for successful execution of IPD in the cases investigated, a few concerns regarding collaborative use of building information modeling (BIM) was expressed. In this study, the authors defined the use of BIM model as a mean to integrate different discipline models during each phase of a project. In all cases except 6, which was completed in 2005, projects used BIM as part of their integrated practice.

Concerns were expressed by the design-build firm in case 2 and the owner in case 5 regarding the level of BIM use by the subcontractors; the concerns were regarding the availability of BIM software to subcontractors and the capability of subcontractors (beyond the MEP, fire protection, and structural steel) to work in 3-D and use BIM collaboratively with other project teams. Nevertheless, the use of collaborative BIM was seen as a great tool for enhancing communication, transparency, collaboration, building relationships, reducing costs, and accelerating processes in all projects investigated.

Visualization and simulation capabilities of BIM gave the project teams in cases 7 and 8 more confidence.

The BIM collaboration between the MEP and fire protection subcontractors in case 4 saved time and money in fabrication and redesign. For example, an electronic scan of the ceiling and integration of the models with the contractor's BIM model allowed the teams to identify the location of the concrete columns that were thought to be missing from the drawings without tearing the ceiling apart.

In case 5, the use of BIM saved time in project planning and enabled the project teams to provide a more accurate estimate.

Other issues addressed by the literature are translation, interoperability concerns, model ownership, and liability when BIM becomes a platform for data sharing and collaboration among the project teams (Hess 2009; Ashcraft 2008).

In cases 2, 3, 4, and 7 the MEP and fire protection subcontractors along with a few other subcontractors merged their models into a single, information-rich model, which allowed the team to translate and integrate their design into a single model for collaboration purposes.

In cases where each project team used different platforms to create their models, the general contractors took on the ownership of integrating and controlling the model. The general trend regarding the accuracy of the model showed that the degree of accuracy depended on the accuracy of specific information provided by individuals and fed to the model by each party. In addition, other approaches were taken in order to avoid any translation and liability issues.

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In cases 5 and 7, where the owners required their project teams to use and assemble their models on the platform specified in the contract, the owner took on the liability and ownership of the model.

Lessons learned

A cross-case comparison revealed that none of the IPD projects suffered from the issues commonly observed in the AEC industry. This supports the assertion by the literature that the delivery method is adequate and successful (Cohen 2010; Becerik-Gerber and Kent 2010; Matthews and Howell 2005). Extracting best practices from the cases reveals a range of principles that act as lessons learned for achieving successful IPD projects as well as overcoming major barriers when implementing IPD. These are discussed below.

Selecting the right team early and based on quality

IPD demands more diligence from the owner in selecting project teams. Unlike traditional projects where teams are selected based on the lowest bid, IPD calls for a best-value selection, meaning that teams are selected for the best design for the proposed budget. Two methods of team selection were observed in the cases investigated:

- sole selection by the owner and
- request for qualification (RFQ) followed by request for proposal (RFP**).**

In cases 1, 2, and 4, the owner selected the firms solely based on their long-standing previous relationship. In cases 5, 7, 8, and 9, the teams were qualified through an RFQ process. The qualified teams were then eligible to compete in the RFP and propose a design.

A common pattern emerged suggesting that all firms selected by the owners exhibited an ability to participate extensively in the planning and design phase of the project. Being an integrated supplier allowed cases 1 and 2 to participate in the early phases of planning, design, and as the construction process moved along. The construction firms in cases 3, 8, and 9 had long histories of embracing collaborative design and construction and had been practicing informal versions of IPD and lean construction in the past. Some of the qualities and characteristics that owners look for in IPD teams include:

- Team's ability to participate extensively in planning and design
- Subcontractors who are already integrated: who have the engineering and trade teams in-house
- Team's ability to use information technology
- Companies and individuals, who are open-minded, familiar with IPD, and able to work collaboratively with other teams
- Teams that are able to work on an open-book basis in the sense that the amount of profit they make is transparent to all project team members
- Previous working relationships with other teams and previous IPD performance

With the exception of the last point, all of the nine cases embodied the above characteristics.

Reconciling project goals

The analysis showed that it is necessary for the owner to provide the IPD team with a set of project goals in terms of scope, quality expectations, budget, schedule, and possibly

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programming the project well ahead of the start of design in order to approve it when meeting with the IPD team for the first time. Two trends were observed in the establishing and reconciling of project goals: some owners selected their IPD project teams and then reconciled their goals, while others established their goals and then selected their IPD project teams.

The owner in cases 2, 3, 8, and 9 invited the key project teams to set the scope and goal, and engaged in a goal-setting session that set the budget, described their expectations, and laid out specific project roles. As a result, the teams were able to design the project so that it fit the quality and budget set by the owner.

Alternatively, in cases 1, 5, and 6, the owner set the project goals as well as approved the budget, scope, and planning *before* inviting and meeting with the IPD team. These cases reported more change orders.

In case 4, the owner provided the teams with set target schedule, target cost, and target quality but could not reconcile it with the IPD team due to time pressure. As a result, the IPD team rejected these set targets after the design started. This was problematic, as the owner had to issue a change order and increase the budget, which affected the target price and project schedule.

Setting procedures for problem solving and resolution

The cases presented an established mechanism and atmosphere for dealing effectively with problems, which is an essential factor for avoiding legal disputes. None of the four cases completed went through a legal process to reach resolution for their projects, and the remaining five cases that currently under design or construction have not seen any legal disputes that reached a legal resolution. All integrated projects placed a procedure in their contracts calling for the formation of an IPD core team. At a minimum, the IPD core team was comprised of representatives from the owner, contractor, and architect teams. They scheduled meetings to monitor progress and handle issues concerning the project.

In case 1, the dispute resolution board reported a couple of issues, but these issues were solved at the project level and never were acknowledged by the board. In case 3, the core group was comprised of executives forming a main ten-party core group that were part of the IFOA agreement. Forming a core group in case 5 allowed the team to meet and discuss any disputes that arose during the week and forced them to solve these issues.

Cases 4, 8, and 9 reported two IPD core teams, one comprised of technical experts such as representatives from contractors, architects, and general managers. This allowed them to make the necessary day-to-day decisions on the spot. The other team was comprised of executives including lead architects, lead contractors, and owner representatives in addition to having a core team handling day-to-day issues. The senior executive team was responsible for making important decisions on issues that could not be resolved at the project level.

Having an IPD core team also provides an environment that reduces the adversarial nature of the interaction between the project members by promoting openness and honest discussions. It also provides collaboration for problem solving and helps build relationships. In all projects, IPD helped project teams promote a level of openness by encouraging them to speak honestly about how they felt about project decisions. Interviewees of case 9

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reported that conversations still can get heated, as they can in traditional projects, but that IPD allowed these heated discussions to come to reasonable conclusions.

In case 2, all project members gathered to promote participants from different disciplines to engage in discussions. This not only helped the project, but also built strong relationships between the participants even outside of the project by discovering commonalities.

Interviewees of case 7 believe that having collaborative projects helped their team look out for each other's responsibilities, and left no room for hiding from responsibilities.

Providing continuous organizational and project-level support

IPD involves a change in cultural paradigms and demands more collaboration among project participants. The participants were asked how they were able to overcome the changes that came with IPD. The answer stated by most participants was support from their organization and strong support from their organization's leadership. All cases were able to overcome problems by staying committed to their decision to employ IPD. The second widely offered answer was that firms' structures and past practices made the transition easier.

Lastly, participants stated that an organization's ability to function in an IPD environment was important to overcome communication issues between the team members.

Therefore, the first step for transitioning to IPD requires training at the organizational level. Educating teams on the organizational level has the potential to cut down on training costs during each phase of the project. This is not to devalue the importance of project level training, but case 2 reported that the amount of time spent on training teams during projects reduced their productivity rate at the beginning. Training individuals proved to be an effective way of overcoming cultural barriers.

Providing collaborative and fully integrated project environments

The analysis provides evidence that the early collaboration of the main players (owner, architect, contractor, engineers, and subcontractors) allowed for extra savings and early completion of five projects investigated. Early collaboration of contractors and subcontractors in cases 1, 2, 4, 6, and 7 allowed for early completions and extra savings. Most case participants agreed that true integration happens only when all the key project teams are able to unite their discipline-specific BIM models into a single model and participate on all aspects of the project from early design to construction completion. According to Cohen (2010), AIA's most recent definition describes IPD as *"a project delivery method distinguished by a contractual agreement between a minimum of the owner, design professional, and builder, where risk and reward are shared and project team's success is dependent on project success."* The industry cases studied reveal that achieving full integration was possible without having a multi-party agreement or shared risk and reward. Three of the cases in this study were delivered by using the design-build delivery method and were able to assemble their teams in a way that enabled them to achieve true integration. This confirms the AIA's assertion that using design-build in its best practices aligns with the IPD definition (AIA California Council 2008). In addition, one factor that helped these three cases to achieve true integration was an environment of preexisting trust between the owner and the design-build entity. However, in cases 5, 6

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and 9, where there was no specific prior relationship among the owner, architect, and contractor, having a relational element helped project teams build trust and achieve collaboration intentionally. Having a relational contract with specific clauses that encourage collaboration was considered crucially important to the execution of successful IPD projects. These relational contracts forced parties to communicate openly and provided the necessary environment and tools for project participants to build relationships.

Limitations and future research

While this study provides an overview of successful IPD practices, several IPD and non-IPD projects are worth exploring. There is a need to explore why there are so few IPD project examples, what differentiates the design-build practices from IPD, and what are the common barriers to widespread IPD adoption. This study draws conclusions from nine industry cases. Five of the cases are either under construction or design. The authors plan to have a follow up investigation when all projects are completed to determine if the projects were kept on the same course as they are described in this paper.

There is a need for broader IPD case projects with more diversified contract models such as the AIA C195, AIA C191 and ConsensusDocs 300, and other contract types with relational elements. A cross comparison of the practical benefits of each contract model will help to shed light on legal concerns surrounding IPD.

The role of state and local procurement also deserves more attention, as this is a major impediment to wider adoption of IPD in public projects. The discussion of technology in this study was limited to collaborative use of different discipline models; there is a need for more detailed exploration and use of different modes of BIM use.

Although the authors didn't intentionally focus on projects in California, eight out of nine cases are from the state of California. This may suggest that the State of California is the pioneer in implementing this new delivery method. Nevertheless, a broader investigation of IPD cases outside of California is needed, as it will allow discovering differences in practice of this delivery method.

Conclusion

This study focuses on investigating how successful IPD projects overcame common barriers, which have impeded IPD's widespread acceptance. Successful transitions to IPD require projects to overcome some of the prevalent barriers when implementing IPD. The study explored nine different integrated practices within the AEC industry. A cross case analysis revealed that each case, depending on their circumstances, had different ways of implementing IPD. From this, it is clear that the degree of integration varies from case-to-case. The extent to which each case embodied IPD characteristics varied by public laws, duration of projects, and the budget for each project. This suggests that each project is unique, and the potential to employ IPD principles should be analyzed and considered case by case for each project.

The research has highlighted a number of criteria that must be implemented to achieve a fully integrated project. In all of the cases investigated, the adoption of IPD was proportional to

- organizational anticipation,

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- training of individuals, and
- establishing a collaborative framework within IPD teams.

These were found to be crucial for achieving a successful transition to IPD. A successful transition to IPD required companies to have the procurement ability and to be inherently structured in a way to support IPD. Also, widespread adoption of IPD will depend on the amount of legal support in both public and private sectors. Nevertheless, several new findings extracted from the best IPD practices reveal lessons learned that could be used by industry professionals interested in IPD.

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