Journal of Engineering, Project, and Production Management
2020, 10(2), 147-161

Integrated Project Delivery (IPD): An Updated Review and Analysis Case Study

Marina L. Viana[1], Bonaventura H. W. Hadikusumo[2], Mazlina Z. Mohammad[3], and Zahra Kahvandi[4]

[1]MS, Asian Institute of Technology, Vietnam campus, Building B3, University of Transport and Communications, Lang Thuong Ward, Dong Da District, Hanoi, Vietnam. email: marina_lapa@hotmail.com

[2]Associate Professor in the Department of Construction, Engineering and Infrastructure Management at the Asian Institute of Technology AIT, Bangkok Campus. Email: kusumo@ait.ac.th

[3]Senior Lecturer, Faculty of Civil Engineering, Department of Construction Business and Project Management(CBPM), Universiti Teknologi MARA (UiTM), Malaysia. Email: mazlinazaira@gmail.com

[4]MSC, Project and Construction Management, MehrAlborz University (MAU), 36, Danesh Sani Crossroad, Salehi St., Fakouri St., North Kargar Ave., Tehran, Iran. Email: z.kahvandi@gmail.com (corresponding author).

Project and Production Management
Received December 15, 2019; received revision February 7, 2020; accepted February 8, 2020
Available online March 15, 2020

Abstract: Integrated Project Delivery (IPD) is introduced as a new delivery system that fosters high efficiency by delivering accurate information and new technologies in a collaborative team environment. In this sense, the research aimed to review the IPD principles and their main categories, such as contract, process, information & modeling (I&M), team and communication as well as perform a qualitative analysis to illustrate the current research trends. The qualitative analysis performed was made through a series of collected articles from 2001 to 2018 in 08 different scientific database websites. In terms of the results, the contract category illustrated a strong trend, where the studies are focus on collaborations and frameworks to enhance high efficiency in construction. In the I&M category, demonstrated an increasing trend applying the Building Information & Modeling (BIM) subject as well as team category, where showed the importance of a well-structured team and their impact on the project., The process and communication categories illustrated a weak trend, allowing opportunities in the field. Finally, the current study reviewed and analyzed the IPD and its main categories allowing a solid basis for future research.

Keywords: Integrated project delivery, analyses, trend, construction.

DOI 10.2478/jeppm-2020-0017

1. Introduction

Standard delivery methods such as design-build, design-bid-build, and construction management are traditionally employed in the construction industry and although these methods are used for decades, a wide range of professionals are dissatisfied with the outcomes (Hall and Scott, 2016; Perlberg, 2009; Lichtig, 2006; Alves and Shah, 2018). These dissatisfactions could be addressed as the projects often suffer from low quality, time and cost overruns, among others (Lichtig, 2006; Alves and Shah, 2018). In this regard, currently, the construction complexity is increasing rapidly and according to Hamzeh et al. (2019), the delivery methods being applied are considered inappropriate due to the inability to follow the modern trends, causing as a direct effect the dissatisfactions mentioned. In this sense, nowadays the proper delivery approach is considered crucial and significant for a project overall success (El-adaway et al., 2018; Kent and Becerik-Gerber, 2010). To overcome and improve the current delivery methods, IPD immerges as a new construction approach that increases the project performance through a highly collaborative process (El Asmar et al., 2013; DeBernard, 2008).

In this regard, IPD seeks to improve the triple constraint (cost, time and quality) outcomes by aligning the project team incentives and goals as well as applying a shared risk and reward, early involvement and a multiparty contract agreement (Alves and Shah, 2018; Hall and Scott, 2016; Sive, 2009). The American Institute of Architects (AIA) defines the method 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 the project phases” (AIA, 2007). The IPD delivery method possesses main study categories, being them the contract, process, information & modeling, team and communication, where at the same time are the most distinguishing characteristics from the traditional methods (Pishdad-Bozorgi and

Srivastava, 2018; El Asmar et al., 2015). In this regard, the current study aims to review and define the IPD approach and their main categories as well as analyses their current research trends, where all information is presented in one single study. In this sense, the study is divided into six sections. In the first section, IPD principles, benefits and challenges were stated. Second, the IPD main categories were review and defined. Third, the research methodology is illustrated. Fourth, data analysis, where a survey in 08 different publisher houses websites was performed. Fifth, discussion regarding the results. Lastly, in the sixth section, the conclusions and recommendations were made for education and future research projects regarding the topic.

2. Literately Review

2.1. Integrated Project Delivery

The history of the delivery methods stared in the 1940s with the called design-bid-build approach, where was the most widely used in the United States for a long period of time (Kent and Becerik-Gerber, 2010; Miller et al. 2000; Pishdad-Bozorgi and Srivastava, 2018). According to Kent and Becerik-Gerber (2010) or Hamzeh et al. (2019), as a result of the design-bid-build method, a segregating process was created, where the process was directly through one contractor, owner and architect, nurturing the project from conception to completion phase. However, due to this process, multiple cultures were created, causing issues such as inefficiency, fragmentation and resource waste (Gallaher et al., 2004). These issues were partially tackled years later, in the 1960s with the start of the new delivery method, the construction management method has used an approach that supervises and controls the project teams and information (El-adaway et al., 2018; Hamzeh et al., 2019). According to Kent and Becerik-Gerber (2010), 30 years later, in 1990, another new method called the design-build method was created aiming to erase the reaming issues as well as improve the cost, schedule and quality. Although the method has demonstrated a wide range of improvements, the quality of the project decrease significantly as compared with the previous design-bid-build and construction management methods. To improve the new issues, project alliancing, commonly referred to as IPD, surged as brand new delivery approach to improve the main traditional ones, as design-bid-build, design-build and construction management (AIA, 2007; Fischer et al., 2017; Mesa et al., 2016; Gallaher et al., 2004; Kent and Becerik-Gerber, 2010). In this sense, IPD focuses on improving the essential project characteristics, such as time, cost and quality (Azhar et al., 2014; Harrison et al., 2016). For such improvement, some tools are applied such as stakeholders early involvement, open communications, collaborations, goals alignment, BIM technology as well as fair and impartial arrangements for all parties involved (Kahvandi et al., 2017; Harrison et al., 2016; Hall and Scott 2016; Fischer et al., 2017; AIA, 2007; Raisbeck et al. 2010).

2.2. IPD Principles

The IPD method requires specific principles for a proper application (Fischer et al., 2017). In this regard, according to AIA California Council (2014), the principles in question could be divided into eleven different subjects, being them: optimize the whole, not the parts; early and clear goal definition; collaboration; integration (people and systems); joint ownership; respect; trust; transparency; safe environment; shared risk and reward and lastly good technology along all the seven phases. The researchers believe that some principles have more impact and importance on the project than others. For example, according to Hanks (2015), the second principle, early and clear goal definition, is considered by him the most important between all, on the other hand, Azhar et al. (2014) and Fischer et al. (2017) believes the seven principles, called trust, is the most essential one. It is important to mention that some principles are responsible for some characteristics improvement. For example, in terms of the team aspect, according to Gallstedt (2003), the shared risk and reward principle can generate mutual goal achievement, where according to El Asmar and Hanna (2012), the same principle generates other characteristics, such as leadership and respect.

2.3. IPD Benefits

The IPD method can generate several benefits in a project, such as cost control, time management, quality improvement as well as control of unforeseen issues (Collins and Parrish, 2014; Glick and Guggemos, 2009). These benefits could be generated from the stakeholder's alignment since the first phase, called conceptualization. As a result of early collaborations, the estimations are considered more feasible and closer to reality as compared with the traditional methods (Fischer et al., 2017; Lee et al., 2013). The estimations in question have a significant impact on the cost and time criteria, where is improved significantly as a result of fewer changes and proper forecasting (Azhar et al., 2014; Kahvandi et al., 2017). Furthermore, IPD focus on project improvement, where the achievement of efficiency in all aspects is considered essential. For example, some characteristics for such improvement could be addressed as results through integration, agreement, communication, technology and minimum waste of material (Fischer et al., 2017; Lichtig, 2006; Lee et al., 2013). Some of these results are considered more essential than others, for example, communication technology (Fischer et al., 2017). In terms of the communication, due to a higher application, the stakeholders are aligned in all aspects, since the day-to-day activities to the final goal, thus providing all parties proper information and later decision making (Kelly and Ilozor, 2013; Fischer et al., 2017; Perdomo and Cavallin, 2014). In terms of the technology result, as the essential decisions are made in the early stages, the 3D and drawings have minimum or non-changes as well as the constructability, reworks and wastages are reduced (Dossick et al., 2013; Perlberg, 2009; Matthews and Howell, 2005).

As the issues above mentioned are reduced, the quality criteria are immediately improved. The quality criteria in IPD are considered by El Asmar et al. (2015) one of the most important being perfected and improve by implemented the IPD method. In terms of quality measurement, the procedures require specific steps, such as quality guarantee, quality control, project, and product inspection. It is important to mention that in the end, the results need to meet the clients' expectations as well as the level previously agreed in the contract (Fischer et al., 2017; El Asmar et al., 2015). When it comes to quality procedures in the public sector, even though in IPD the quality criteria are considered higher than the traditional methods, the strict rules and policies harm all the process and as a result, has low popularity, however, is predicted to increase in the upcoming years (Hall and Scott 2016; Kahvandi et al., 2017). Although the IPD is still growing in the public as well in the

private sector, the method is supported by a large share of researchers. For example, according to Mossman et al. (2010), the clients attain more value due to less energy cost, reduced documentation and time, contractors less rework and more importantly the cost reduction. In this regard, the Achieving Excellence in Construction (2003) states that for single projects the construction cost could reduce 2-10% average and for a series of projects could reduce up to 30% in addition to the time schedule. In terms of specific areas of reduction, according to Khemlani, (2009) and Hassan (2013), the structural design could reduce the expected cost and time, where the time could reduce from 15 months to 08 months. In short, the IPD benefits has impact since the first until the last phase with aspects such as better outcomes, open and easy collaboration, transparency, equal representation, single agreement, precision estimates, increased efficiency, cost reduction, time reduction as well as quality improvement (Fischer et al., 2017; AIA, 2014; El Asmar et al., 2015; Perlberg, 2009; Matthews and Howell, 2005; Mollaoglu-Korkmaz et al., 2013).

2.4. IPD Challenges

IPD has several benefits in all the project phases and parties involved, however, for a successful outcome, such a method has challenges to overcome (Ebrahimi and Dowlatabadi, 2018; Ghassemi and Becerik-Gerber, 2011). In this sense, according to Ghassemi and Becerik-Gerber (2011) in this delivery system occurs four main challenges, being cultural, technological, legal and financial. In terms of cultural, the construction industry has mainly implemented the traditional delivery system, previously mentioned as Design-Bid-Building, whereas a result some construction companies could be unwilling or reluctant to apply a different approach (Fischer et al., 2017; Roy et al., 2018; Lichtig, 2006; Ilozor and Kelly, 2011). To overcome this challenge, according to Fischer et al. (2017) one possible solution could be a training system for the team and overall parties aiming to demystify the method (Ilozor and Kelly, 2011). To prove the efficiency of such a solution, Ghassemi and Becerik-Gerber (2011) conducted a survey to demonstrate that the intensive training system appeared to help the transition from the traditional method to IPD. Thus, the application of intensive learning and personal behavioral changes aiming to overcome cultural challenges could be seen as a solution (Ghassemi and Becerik-Gerber, 2011; Ilozor and Kelly, 2011; Fischer et al., 2017; Lichtig, 2006).

In terms of the second IPD challenge, called technological challenges, could be addressed as the liability, ownership, and interoperability to implement the integrated software's into the project (Kent and Becerik-Gerber, 2010; Hess, 2009; Ashcraft, 2008). As previously mentioned, the IPD method integrates people and systems, thus an integrated software is considered an essential (McCurley and Powell, 2015; Davies and Harty, 2013). In this regard, it is common to use the BIM software, however, this could create concerns for new users. According to Ghassemi and Becerik-Gerber (2011), some concerns are related to software availability as well as the subcontractors' capability to develop their work. Another possible concern appointed by Davies and Harty (2013) could be addressed as the control over information as well as high costs and lack of human resources available regarding the software knowledge. Thus, the researcher Rached et al. (2014) states that to overcome such a challenge applying BIM training courses previous to the project commencement could increase the popularity and the use. In terms of the third challenge, named legal challenges, the main issues could be addressed as the insurances and liabilities applied in the method (Rached et al. 2014; Ashcraft, 2008). In this sense, the current insurances assign the liabilities to each party involved in the project and this could create a complex environment-related to proper management of risks and insurance allocation (Cohen 2010; Sive 2009; Perlberg 2009). To overcome those issues, some construction companies selected a contract with a multi-party agreement (indicated by applying IPD) that is suitable within the traditional insurance companies were at the same time eliminate or mitigate the capability to build a lawsuit between the parties (Rached et al. 2014; Ghassemi and Becerik-Gerber, 2011; Sun, 2013; Ashcraft, 2008). Finally, the last challenge appointed by Ghassemi and Becerik-Gerber (2011) is the financial challenges. Such a challenge could be considered as the issue to select the compensation and incentive structure as well as according to Kahvandi et al., (2018) a weak matrix structure, lack of coordination and training could be considered part of the problem as well (Fischer et al., 2017; Cohen 2010; Rached et al. 2014). When it comes to compensation and incentive topics, the traditional financial contracts foster individual responsibilities that cause to inhibit collaborations, while in the IPD method are applied to increase the teamwork with mutual compensations and incentives (Rached et al. 2014). For example, in IPD the risks and rewards are shared among the team in subjects such as targets, profits and costs that when properly applied the overall parties tend to participate in all activities, generating a method to overcome the financial challenges (Ashcraft, 2008; Rached et al., 2014).

2.5. IPD Implementation in Construction

The application of IPD in the architecture, engineering and construction (AEC) industry has rapidly increased due to the high rate of success, especially when it comes to subjects such as cost and time (AIA, 2014; Fischer et al., 2017). As previously mentioned, the IPD method has distinguished modifications from the traditional methods, being their majority found in the contract, process, information & modeling, team and communication categories (El Asmar et al., 2015; Ashcraft, 2008; Rached et al., 2014).

2.5.1. Contract

The contract category is considered by Alves and Shah (2018) or Becerik-Gerber and Kensak (2010) as a success factor for construction projects due to their strict specifications on several aspects. However, the current contracts presented in the industry are having an unsatisfactory performance, opening a margin for lawsuits and unnecessary costs. Due to that, the application of IPD integrated contracts has been increasing the popularity since created an agreement between the owner, contractor, designer and other key participants. The agreement in question is through a defined and integrated alliance between the main roles, such as responsibilities, structures, process and design drawings (Fischer et al., 2017; Ashcraft, 2010; Pishdad-Bozorgi and Srivastava, 2018; Zhang et al., 2018; AGC, 2009). In this sense, according to Ashcraft (2010) and Fischer et al. (2017), the IPD contract has five major structural elements, described as early involvement of key participants, shared risk and reward based on project outcome, joint project control, reduced liability

exposure, jointly developed, and validated targets (Ashcraft, 2010; Fischer et al., 2017).

2.5.1.1. Early involvement of key participants

Considered as the most critical and vital element by Ashcraft (2010), the early involvement of key participants describes the parties collaboration occurring at the project earliest possible moment generating several benefits to the project (Ashcraft, 2010; Fischer et al., 2017; El-adaway et al., 2017; Leicht and Harty, 2017). In this sense, some benefits can be described as the increase of shared knowledge in the first phase of the project, creating an effective, feasible and constructible design as well as create an environment that promotes diversity and creativity (Fischer et al., 2017; Chan et al., 2016; AIA, 2014). Thus, the application of early involvement could significantly reduce reworks and risks during the construction phase (El-adaway et al., 2018; Ashcraft, 2010).

2.5.1.2. Shared risk and reward based on project outcome

This element is related to the project goals and objectives achievement through shared risks as well as rewards between the team key participants, where the total amount of profit or debt would be shared with the team instead of individual during the project progress (Ashcraft, 2010). In this regard, Ashcraft (2011) showed that this element could divide into four components, defined as:

i. Reduced liability;

ii. Limited options for change orders;

iii. Owner guarantee of direct costs

iv. Profit tied to project outcome.

As a positive result of the components, the application fosters the parties to achieve the project objective and goals with open communication and shared information, since the profit or loss would be a result of the team performance (Bygballe et al., 2015; Lahdenperä, 2012).

2.5.1.3. Joint project control

In the joint project control, open communication with a free exchange of information where all parties should be heard and respected is considered the essence of the element (Fischer et al., 2017). In this regard, this element enforces a fairness environment, where balances the interests and provides security against one party over another (Ballard et al., 2011; Leicht and Harty, 2017). The fairness environment is achieved through a project management team with the power to apply particular rules as well as enforce the team to trust in each member for an overall agreement in any subject (Ashcraft, 2010). Thus, the application of joint project control aspects could decrease some defensive behavior and avoid unnecessary contingency expenses in the project (Fischer et al., 2017; Ashcraft, 2010; AIA, 2014).

2.5.1.4. Reduced liability exposure

The Reduced liability element is applied to enforce the parties to assume the project responsibilities instead of blaming others for mistakes and miscommunications (Alves and Shah, 2018; Fischer et al., 2017). As the blaming problems occur, the element serves to support the creative area of the project by protecting parties responsible for new ideas along with open communication and trust (Ballard et al., 2011; Leicht and Harty, 2017). However, if not properly applied the problems in question could a law claim under the Restatement of Torts in section 552, cause friction and unnecessary costs for the project (AIA, 2014; Ashcraft, 2010). Thus, reduced liability exposure element has the ultimate goal to increase communication among all parties, induce creativity as well as reduce unnecessary contingencies in claim laws (Alves and Shah, 2018; AIA, 2014; Fischer et al., 2017).

2.5.1.5. Jointly developed and validated targets

The last element in the IPD contract, jointly developed and validated targets, is used to ensure the project goal and targets are achievable, feasible and realistic (Fischer et al., 2017; Ashcraft, 2010). These characteristics, according to Fischer et al. (2017), lead the team to gain responsibility, focus and incentive to achieve results, where an aggressive and unrealistic goal could affect the team performance due to a stress environment (Leicht and Harty, 2017; Fischer et al., 2017; Lahdenperä, 2012). Thus, due to all benefits that could bring to the project this element is considered by AIA (2014) as the IPD project mission statement.

In this sense, all the five major structural elements could be applied in the two types of IPD contract, being them the multi-party contract and the poly-party contract.

2.5.1.5.1. Multi-party contract

The first contract type could be called as a multi-party contract, considered by Fischer et al. (2017), as the most common between the IPD systems due to similarity to the traditional contract. This contract has two levels, called a primary and a secondary contract. A primary contract is a single contract between the three most important parties, such as the owner, designer, and contractor; that shares all the risks and rewards involved in the project (Fischer et al., 2017; AIA, 2014; Ashcraft, 2010). In the secondary contract, the designer and contractor are able to develop individual subcontracts with others, such as the consultants and builders (Ashcraft, 2010). In summary, as the multi-party contract align all major party in one contract, the owner can decrease the mediation process between the designer and contractor generating a fast exchange of information (AIA, 2014; Ashcraft, 2010).

2.5.1.5.2. Poly-party contract

In the second IPD contract type, called poly-party contract, all parties involved in the project sign a single agreement, as opposite from the multi-party contract with the two levels (AIA, 2014; Ashcraft, 2010). In this type, the primary and secondary levels in the multi-party contract are jointed into one large agreement contract uniting all parties (AIA, 2014). This agreement, according to Ashcraft (2010), allows the owner direct access to all key participants, generating a high communication and commitment environment. It is important to mention that it is considered more complex due to the number of parties involved, however, it possesses a high level of issue resolutions due to the fast information exchange (AIA, 2014).

2.5.2. Process

In the IPD approach, occurs seven phases in the project orderly describe as conceptualization, criteria design, detailed design, implementation documents, agency coord/final buyout, construction and finally, closeout phase (Fischer et al., 2017; AIA, 2007; Wamelink et al., 2012). In this sense, in the first phase, called conceptualization, all key stakeholders, such as the agency,

owner, designer, consultants and builders are aligned in a mutual agreement to develop the project planning and scope (Harrison et al., 2016; Hall and Scott 2016). In the conceptualization phase, some of the outcomes could be addressed as the scope, preliminary schedule, initial cost, benchmarks and others (Fischer et al., 2017; Mesa et al., 2016; AIA, 2014). The second phase, called criteria design, all stakeholders from the previous phase remain present and another party is added to the project, called trade builders (Raisbeck et al. 2010; AIA, 2014). In this phase, is defined the goals, structural, M&E, quality level, building components, and others, while at the same time some definitions of the previous phase are changed or improved and stipulated fixedly from this phase forward (Fischer et al., 2017; Scott et al., 2013).

Concerning the third phase, called detailed design, all parties remain presented and no new party is added from this phase until the last one (Raisbeck et al. 2010; AIA, 2007). In this phase, the specifications and details are developed based on the agreement of the previous phases while ensuring that no changes will be further made (Wamelink et al., 2012; AIA, 2014). In the fourth phase, called implementation documents, the materials and documents are officially generated, such as financing, procurement, permits as well as legal requirements as all the designs and specifications are fixed (Mesa et al., 2016; Wamelink et al., 2012; Fischer et al., 2017; AIA, 2007). In terms of the fifth phase, called agency coord/final buyout phase, is an exception phase since it runs parallel with the second, third and fourth phases, due to the agency providing information to the development team (Harrison et al., 2016; Raisbeck et al. 2010). In the sixth phase, called the construction phase, the project execution starts applying the designs and specifications defined in the previous phases (Fischer et al., 2017; Harrison et al., 2016). As the designs and specifications are fixed, the modifications decrease drastically, while only periodically reviewing the project schedule and progress (Mesa et al., 2016; Scott et al., 2013). Finally, the seventh and last phase, called the closeout phase, is considered by Wamelink et al. (2012) as the only phase similar to the traditional method (Wamelink et al., 2012). This last phase is the finalization of the project, where generate outcomes such as as-built drawings, warranty, occupancy and completion of notifications documents (Scott et al., 2013; AIA, 2007).

2.5.3. Information and Modeling

For the implementation of the IPD method some essential modeling tools with specific technologies, collaboration and automation capabilities are needed (Kalach et al., 2018; Lesniewski and Berkebile, 2018). The capabilities in question could be addressed according to Reginato and Said (2018), as a "modeling of design intent; multi-disciplinary performance analysis; building geometry data; merged with construction site data; delivery of as-constructed facility model; 4D visualization; virtual prototyping; transparent, interoperable, and reliable data transfer with third-party applications; automated propagation of changes and integrity checking, and computer-aided manufacturing and assembly" (Reginato and Said, 2018). Thus, to support the delivery system, an efficient information model with coordination and the integrated process are required, where the BIM technology surges as a tool to achieve these objectives (Kalach et al., 2018; Lesniewski and Berkebile, 2018; Azhar et al., 2014; Owen et al., 2009; Ashcraft, 2008). The BIM could be defined as is-a virtual drawing, that joins all areas and systems into a single virtual model, allowing all project member to develop an accurate and efficient drawing as contains an exact geometry and data platform, as well as characterizes the geometry, building elements quantities, schedule, cost and material estimations (Bazjanac, 2006). In terms of BIM benefits, according to Eastman et al. (2008), some benefits could be organized in four major groups as pre-construction, design, construction and post-construction groups (Eastman et al., 2008; Ashcraft, 2008). In addition to the group's definition benefits, as the software use increases during the phases, the collaboration within the team increases as well, leading to profitability, cost and time improvement (Ahmad et al., 2018; Azhar, 2011). Finally, BIM has been creating a fast and efficient collaboration between the parties, providing an effective tool for managing construction projects (Reginato and Said, 2018; Azhar et al., 2014).

2.5.4. Team

In the IPD systems, the employees combine their individual strengths to create a high level of group outcome by applying collaboration and trust (Laurent and Leicht, 2019). In this regard, collaboration and trust are the key characteristics in the IPD teams, where the commitment to achieve common goals, processes and outcomes with mutual accountability are essential (Laurent and Leicht, 2019; Guan, 2018; Azhar, 2011). According to Fischer et al. (2017), the employees involved must have different abilities such as creativity, efficiency, multidisciplinary, self-managing and self-coordinating for a successful result. Further the group definition, some rules are encouraged, such as clear communication, fast exchange of information and collaborations all through a united group, where individual performances will not be accepted (Garcia et al., 2016; Azhar, 2011; Ashcraft, 2011; Laurent and Leicht, 2019; Zhang et al., 2016). As the results must be through a united group, Baiden et al. (2006) created a team integration matrix (TIM) to help identify the team collaboration and integration, where such characteristics are evaluated through six main dimensions. The TIM matrix applies a framework concept with dimensions that should be evaluated and mapped against team performance (Baiden et al. 2006; Fischer et al., 2017). The levels according to Baiden et al. (2006) is illustrated in Table 1.

Table 1. Team integration achievement (adapted from Baiden et al., 2006).

Dimensions	Full integration	Partial integration	No integration
Team focus and objectives	Mutual focus and goal, performing towards mutual objectives	Individual objectives, however still in line with the objectives	Individually objectives only
Operation with no limits	No individualism, performing towards mutual objectives	Perform as individuals, however, support collaboration	Alignment and affiliation to individual organizations
Unrestricted information sharing	Project information available to all parties	Information access only through team sections	Information only to the member responsible
Team creation (single)	A single team performing in a common office	Individual performance, however in common office	Individual location and operation
Opportunities and respect	Equal treatment for the members involved in all phases	Member competence recognition, however only in the field of expertise	Contributions only allow to the member specific field
"No blame" culture	Mutual responsibility for problem solving and outcomes	Single responsibility, however, help others to resolve problems	Individual responsibility for every problem and error made

In terms of team organization, according to Fischer et al. (2017), the organization varies according to two different categories, such as the project sizes and technical details. In the size category could impact the employee's numbers, coordination and direction while in the technical details category could impact the overall organization (Fischer et al., 2017; Garcia et al., 2014; Dossick et al., 2013). When it comes to leadership arrangements, IPD projects are led by committees that represent all the key parties, such as design consultants, owners, and contractors (Fischer et al., 2017; Ashcraft, 2011). The committee in question is commonly divided into two different levels, such as the project and senior management (Ashcraft, 2011; Laurent and Leicht, 2019; Uihlein, 2016). The first level, project management could be addressed as the responsibility for the overall project delivery address as project goal establishment, resource allocation; financial oversight, functional member's selection, team mentoring, contract administration, dispute resolution and the effectively performance integration of teams (Baiden et al., 2006; Ashcraft, 2011; Laurent and Leicht, 2019).

2.5.5. Communication

The management of technical components, such as schedule, activities, and supplies, as well as effective collaboration among participants, will not prevail without a proper and fast communication (Manata et al. 2018; Azhar et al., 2015). In this regard, the communication category could be defined in two categories called formal type, with characteristics such as email, letter, meeting and informal type with characteristics such as phone calls and day-to-day information exchanged (Fischer et al., 2017; Aaron Sun et al., 2015). The second category, informal communication, is essential in IPD due to the integration, effectiveness, faster process and easy problem solving as a result of all team sharing the same workspace (e.g. big rooms) (Dossick and Neff, 2011; Azhar et al., 2015). In this sense, although the IPD teams work in the same workspace, as the project scale increasing issues such as complex communication occurred (Aaron Sun et al., 2015). The complex communication can be address as missing information, misunderstanding message, different levels of communication and confusion related to responsibility distribution (Aaron Sun et al., 2015; Poole, 2011; Nofera et al., 2011). To overcome these issues, some team behaviors need to change since are directly associated with effective performance. The behaviors mentioned can be classified as monitoring, managing, challenging, and negotiating. In terms of the first behavior, monitoring behavior, the team leaders need to be able to understand the execution process, asses the performances and identify issues as well as potential improvements (Morgeson et al., 2010). In terms of managing behavior, the management level needs to perform with collaboration to resolve differences and use group communications (Manata et al., 2018; Aaron Sun et al., 2015). This behavior simplifies the information exchange between the participants involved while promoting the collaboration into a two-way action (Fischer et al., 2017; Morgeson et al., 2010). Regarding the third behavior, challenging behavior, the team needs to be encouraged to create new ideas, suggestions, and approaches that could contribute to better team performance (Morgeson et al., 2010; Yukl, 2012). The last behavior, negotiating behavior, the team members need to discuss and have mutual concessions aiming proper solutions to all subjects (Meiners and Miller, 2004). Thus, the communication category is considered essential to all project parties, where the success or failure rest on the proper team communication and their ramifications (Manata et al. 2018; Azhar et al., 2015; Aaron Sun et al., 2015; Di Marco et al., 2010).

3. Research Methodology

The present study has the research methodology through a descriptive study and a qualitative analysis. The descriptive study reviews the IPD principles, benefits and challenges and their main categories, such as the contract, process, I&M, team, and communication. For the qualitative analysis was collected articles from 2001 to 2018 in 08 different scientific databases websites aiming

to illustrate the current research trends in each IPD category. The scientific websites in question were ASCE, Taylor & Francis, AIA, Springer Link, Hanson Bridgett, Elsevier-Science Direct, ProQuest and Wiley. In order to select the articles, in the library area of the website was insert the words "Integrated Project Delivery", "IPD" and the categories name "contract", "process", "I&M", "team" and "communication" in the title, abstract, and key-words search in the range of 2001 to 2018. The website results identified in the contract category 29 articles, process 03, I&M 25, team 15 and communication 02 with a total of 74 articles between the time ranges, where it is important to mention that all materials are in the field of construction. Finally, the review and data collection generated tables and figures with essential information that could support researches to understand and analyze the current research trend in the main IPD categories.

The research question is addressed as to how IPD can affect contracts, processes, I&M, team, communication processes, and their current trends in the construction field?

4. Data Analysis

For the present research, 08 scientific databases were selected, including ASCE, Taylor & Francis, AIA, Springer Link, Hanson Bridgett, Elsevier-Science Direct, ProQuest and Wiley. The research collected a total of 74 research studies between 2001 and 2018. Following, the materials collected were distributed in 05 IPD categories, such as contract, process, I&M, team, and communication that illustrated in Table 2. In addition to materials distribution per category, the studies distributed in percentage for a better illustration and understanding as demonstrated in Figure 1. Additionally, Table 3 identified the research references per categories from 2001 to 2018. Finally, Figure 2 to Figure 6 illustrated the materials distribution trend per category in the period of time previously mentioned.

Table 2. IPD scientific database materials from 2001 to 2018.

Category	Contract	Process	I&M	Team	Communication	Total per database
ASCE	17	0	12	9	2	40
Taylor & Francis	6	1	4	3	0	14
AIA	4	0	3	0	0	7
Springer Link	0	0	4	1	0	5
Hanson Bridgett	2	0	0	1	0	3
Elsevier-Science Direct	0	1	1	0	0	2
ProQuest	0	0	1	1	0	2
Wiley	0	1	0	0	0	1
Total per database	29	3	25	15	2	74

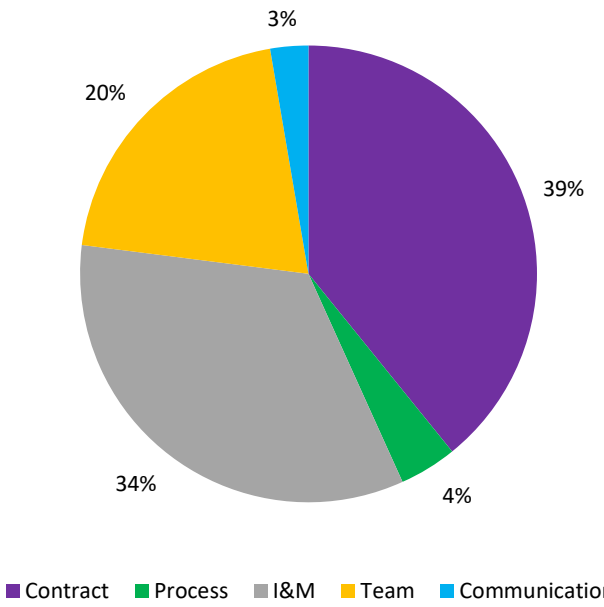

Fig. 1. IPD materials distribution per categories

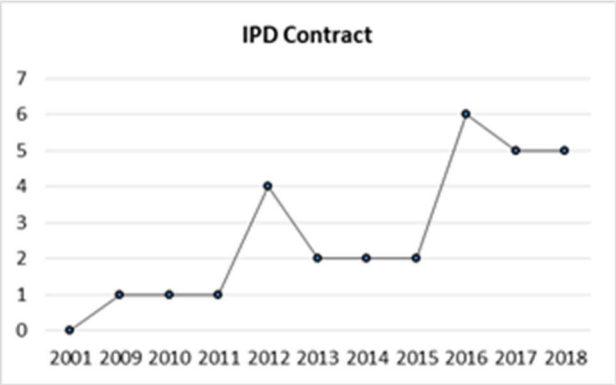

Fig. 2. IPD contract research materials distribution from 2001 to 2018

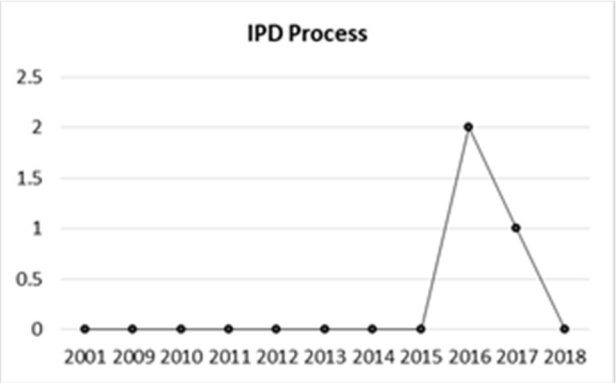

Fig. 3. IPD process research materials distribution from 2001 to 2018

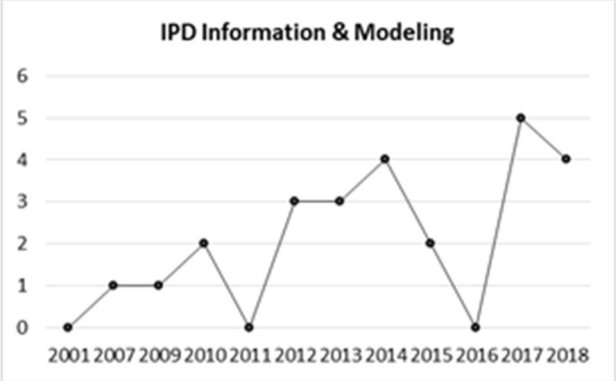

Fig. 4. IPD information & modeling research materials distribution from 2001 to 2018

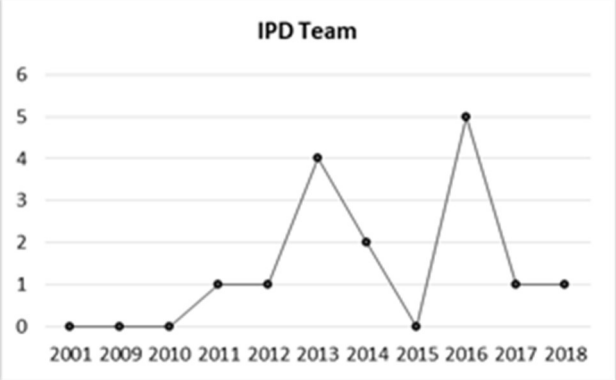

Fig. 5. IPD team research materials distribution from 2001 to 2018

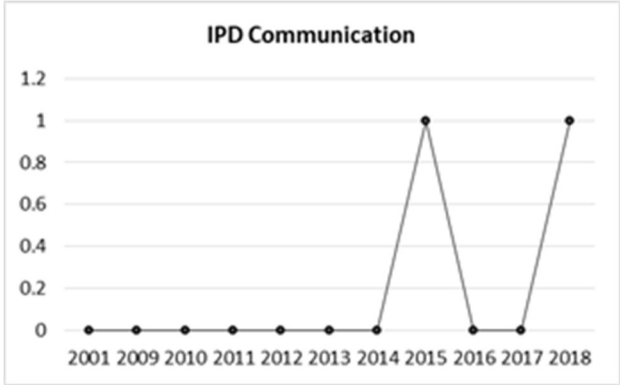

Fig. 6. IPD communication research materials distribution from 2001 to 2018

5. Discussion

The primary studies in IPD started to appear since 2001 in the US followed by Asia, Europe, and Oceania countries (Lee et al., 2013). Since then, the research studies on such topics increased, especially in categories such as contract, process, I&M, team and communication (evaluated in this research). As the studies continue to rise, according to Kahvandi et al. (2017) the materials available can be divided into three periods. In the first period, from 2001 to 2009, the IPD researches were focused on introducing the delivery method with principles and definitions subjects. In the second period, 2010 to 2012, the lessons learned, implementation and contract analysis were the main subjects evaluated, while in the third period, 2013 to 2016, challenges and solutions studies were being presented (Kahvandi et al., 2017). Thus, the IPD path from 2001 to 2018 has changed focus from principles to implementation and finally, challenges and solution aspects.

As previously mentioned, the IPD categories analyzed were the contract, process, I&M, team, and communication. When it comes to the first category, contract, was possible to identify the highest amount of available research materials with 29 of 74 studies. In Table 2, Figure 1 and Table 3 it is possible to identify the number of studies per scientific database, a total of % distribution per categories and the research references, respectively. In this regard, the researches collected has demonstrated a positive trend in contract studies. The studies started to be published in 2009 with 01 study and years later, in 2016, reached a peak with 06 different studies being published in the same year. However, in 2018 the amount reduced to 05 studies, as illustrated in Figure 2. Whiten the materials collected, the IPD studies have demonstrated positive impacts on different subjects, such as collaborations, frameworks, comparative analysis, case studies, symbiotic relationships, agreement negotiations, game theory applications, principles, shared responsibilities, risk and reward, among others. The collaboration, for example, Xie and Liu (2017) founded that such a subject could significantly improve the project outcome in countries such as the United States (Xie and Liu, 2017). To support this statement, Alves and Shah (2018) performed a study that demonstrates the positive impact through collaboration-related words with additional instances and practices to promote such characteristics. To further sustain the positive impact in both research studies, Pishdad-Bozorgi and Srivastava (2018) illustrated that due to collaboration aspects the project could prevent even cost overruns (Pishdad-Bozorgi

and Srivastava, 2018). When it comes to contract frameworks impact, a recent study (El-adaway et al., 2018) demonstrated that such a framework can increase the partnering agreements. In addition, several studies in frameworks, such as multi-party relational contract and metrics illustrated that such topic impact on cost, responsibilities, risk, and reward as well as encourages the team to maintain the project within the target cost (El-adaway et al., 2017; Abdirad and Pishdad-Bozorgi, 2014; Pishdad-Bozorgi and Srivastava, 2018; Xie and Liu, 2017). Thus, it is possible to observe how the IPD contract can positively impact on several contract topics, being the most visual the collaborations and frameworks subjects.

In terms of the second IPD category, process, the number of studies collect was 03 of 74 materials. In Table 2, Figure 1 and Table 3 it is possible to identify the number of studies per scientific database, a total of percentage distribution per categories and the research references, respectively. In this regard, the researches collected has demonstrated a weak trend, was the first study within the research methodology was published only in 2016. In this year 02 studies were released, right after a decrease in the following year, 2017, with 01 study available and 2018 with none, as illustrated in Figure 3. Whiten the materials collected, the studies have different subjects, such as principles and performance analyses. In the principles subject, for example, Fischer et al. (2017) address characteristics such as be buildable, operable, usable, high-performance and sustainable buildings. In addition, such principles could positively affect the team with trust, goal alignment, and gain/pain sharing. Thus, it is important to mention that even though the amount of studies available is still considered slow, the process category has a direct impact on essential characteristics of the project (Mesa et al., 2016).

In terms of the third category analyzed, information & modeling, the number of studies collect was 25 of 74 materials. In Table 2, Figure 1 and Table 3 it is possible to identify the number of studies per scientific database, a total of % distribution per categories and the research references, respectively. In this regard, the researches collected has demonstrated a fluctuation trend over the period given. The studies which started to be published in 2007 with 01 study and years later, in 2017, reached a peak with 05 different studies being published in the same year, as illustrated in Figure 4. Whiten the materials collected, the studies demonstrated different subjects, however, all of them are related to the BIM characteristic varying on applications, benefits, and influential factors, among others. In terms of BIM positive impact applications in IPD, according to Maskil-Leitan and Reychav (2018) and Lesniewski and Berkebile (2018), the application has a direct impact on the concept, design, construction, operation, and maintenance as well as end-of-life IPD projects. Thus, when it comes to I&M necessary for a proper IPD application the BIM application is directly associated (Maskil-Leitan and Reychav, 2018; Lesniewski and Berkebile, 2018; Reginato and Said, 2018; Chang et al., 2017; Azhar et al., 2014).

Regarding the fourth category analyzed, the team, the number of studies collect was 15 of 74 materials. In Table 2, Figure 1 and Table 3 it is possible to identify the number of studies per scientific database, a total of percentage distribution per categories and the research references, respectively. In this regard, the researches collected has demonstrated a strong fluctuation trend over the period given, the first study within the research methodology was published only in 2011. In that year 01 study was released, right after it reached a peak 05 years later, in 2016, with 05 materials published, as illustrated in Figure 5. Whiten the materials collected, the studies have different subjects, such as applications, behaviors and aspects characteristics, among others. In terms of applications, for example, Zhang and Qian (2016) explored the factors that positively impact IPD projects, were, as a result, was identified and classified 04 main dimensions that could impact, such as interaction, stakeholder's characters, contract, and organization, in addition to recommendations (Guan, 2018). To support such results, Garcia et al. (2016) develop a survey with 185 team members and 21 project teams to illustrate how the team category is an essential IPD category (Garcia et al., 2016). The survey results illustrated that team relationships increase the responsibility, workplace environment as well as fosters goal alignment, creativity and productivity (Garcia et al., 2016).

In terms of the last category, communication, the number of studies collected were 02 of 74 materials. In Table 2, Figure 1, and Table 3 it is possible to identify the number of studies per scientific database, a total of percentage distribution per categories and the research references, respectively. It is important to mention that such category possesses the lowest amount of materials available as compared with the others analyzed in this research. In this regard, the researches collected illustrated two equal peaks during the period given were both have 01 available materials in 2015 and the other 03 years later, in 2018, as illustrated in Figure 6. Whiten the materials collected, the studies have different subjects being identified as key communication behaviors as well as the relationship between information and communication. Regarding key communication behaviors, for example, Manata et al. (2018) developed a measurement model aiming to investigate the communication behavior in the delivery system by collecting data from 202 team members. As a result, the existence of four general communications that occur in IPD was discovered, demonstrated and discussed (Manata et al., 2018). To sustain the communication behaviors positive impact, Azhar et al. (2015) performed a survey by collecting 59 data points to investigate the "perception of IPD characteristics on project delivery effectiveness" and "perception that ICT fosters IPD" concluding that major barriers are present, and their perception is influenced by such communication behaviors. Thus, it is important to state that communication has several roots, applications, and all positively impact the project overall results.

6. Conclusion

The current research performed a descriptive study and evaluated the five major areas of Integrated Project Delivery, such as contract, process, information, team, and communication, aiming to analyze the current research trend topics. In this sense, the research has found a total of 74 studies from different scientific databases, in contract, process, information & modeling, team, and communication, respectively. In addition, this study has illustrated the necessity of further IPD application in the construction industry, particularly in process and communication, where both demonstrated the lowest quantity of materials available. Moreover, it is important to mention that IPD has a different implementation process according to the present condition of each country, thus

previous any application the proper research approach is recommended.

In summary, the research materials available has illustrated a positive trend, indicating further and growing research in the matter. The category identified with the highest amount of materials was the contract category, followed by I&M, team, process and communication, with 29, 25, 15, 3 and 2, respectively. In this regard, the result illustrated a strong trend regarding contract in IPD, where the current researches are focus on developing the delivery system with high efficiency matter with collaborations and frameworks for a proper application. In the I&M, the BIM technology is considered essential for a proper IPD implementation, where the majority of studies has such characteristic analyzed, illustrating a strong trend of BIM in construction. The team category has illustrated studies with special focus on member's behaviors, where demonstrated the importance of a good structured team and collaborations between the members and their impact on the project. Regarding process and communication, both with the lowest amount of studies illustrated a weak trend during the period given, where has shown an opportunity for future studies in the matter. Thus, IPD has a strong trend in the construction industry, illustrating a positive research aspect with innovations and future opportunities. Moreover, the limitations of this research are the resources used in the literature with restricted areas where IPD is currently being implemented, such as the United States. However, it is important to mention that IPD has not been completely implemented in determined countries. Finally, the researchers have not accessed all the information on case projects.

Table 3. IPD materials references from 2001 to 2018

IPD Category	References
Contract	(Alves and Shah, 2018); (El-adaway et al., 2018); (Mulholland and Clevenger, 2018); (Pishdad-Bozorgi and Srivastava, 2018); (Zhang et al., 2018); (AIA, 2017b); (El-adaway et al., 2017); (El-Moneim et al., 2017); (Pishdad-Bozorgi, 2017); (Xie and Liu, 2017); (AIA, 2016a); (AIA, 2016b); (AIA, 2016c); (Burnham and Nagata, 2016); (Chan et al., 2016); (Pishdad-Bozorgi and Beliveau, 2016a); (Bygballe et al., 2015); (Ke et al., 2015); (Abdirad and Pishdad-Bozorgi, 2014); (Harper and Molenaar, 2014); (El-adaway, 2013); (El Asmar et al., 2013); (Becker et al., 2012); (Franz and Leicht, 2012); (Jung et al., 2012); (Lahdenperä, 2012); (Gokhale, 2011); (Ashcraft, 2010); (Dal Gallo et al., 2009).
Process	(Fischer et al., 2017); (Harrison et al., 2016); (Mesa et al., 2016).
Information & Modeling	(Kalach et al., 2018); (Lesniewski and Berkebile, 2018); (Maskil-Leitan and Reychav, 2018); (Reginato and Said, 2018); (AIA, 2017a); (AIA, 2017b); (AIA, 2017c); (Chang et al., 2017); (Guo et al., 2017); (Abdirad, 2015); (Solnosky et al., 2015); (Azhar et al., 2014); (Bach, 2014); (Ma et al., 2014); (Solnosky et al., 2014); (Ahn et al., 2013); (Bynum et al., 2013); (Pishdad-Bozorgi et al., 2013); (Lesniewski and Berkebile, 2012); (Molavi and Shapoorian, 2012); (Schumacher and Otani, 2012); (Becerik-Gerber et al., 2010); (Lancaster and Tobin, 2010); (Glick and Guggemos, 2009); (Matsuzaki, 2007).
Team	(Guan, 2018); (Paik et al., 2017); (Garcia et al., 2016); (Pishdad-Bozorgi and Beliveau, 2016b); (Uihlein, 2016); (Zhang et al., 2016); (Zhang and Qian, 2016); (Garcia et al., 2014); (Mollaoglu-Korkmaz et al., 2014); (Dossick et al., 2013); (Mollaoglu-Korkmaz et al., 2013); (Zhang et al., 2013a); (Zhang et al., 2013b); (Zhang et al., 2012); (Ashcraft, 2011).
Communication	(Manata et al., 2018); (Azhar et al., 2015).

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Marina L. Viana is a master degree student at the Asian Institute of Technology AIT, Vietnam campus, enrolled at the Master of Engineering program. Mrs. Viana holds a bachelor degree in Civil Engineering at the University of Southern Santa Catarina State, Brazil. Her research area focuses on construction management topics, such as Integrated Project Delivery (IPD), delivery systems and construction process improvement. In terms of professional experience, she has more than 06 years in several construction and consultation companies in South America, Brazil.

Bonaventura H. W. Hadikusumo is an Associate Professor in the Department of Construction, Engineering and Infrastructure Management at the Asian Institute of Technology AIT, Bangkok Campus. Holder of numerous research on construction management topics, such as project management, construction, health and safety. Professor Hadikusumo obtained his Ph.D. degree in Construction Management at The University of Hong Kong, a master's degree in Construction Management at the Asian Institute of Technology and a bachelor degree in Civil Engineering at Universitas Diponegoro, Indonesia.

Mazlina Zaira Mohammad is a Senior Lecturer in the Faculty of Civil Engineering under the Department of Construction Business and Project Management (CBPM) at Universiti Teknologi MARA (UiTM), Malaysia. Dr. Mohammad holds a PhD degree in Construction, Engineering and Infrastructure Management (CEIM), Asian Institute of Technology AIT, Thailand, master's degree in Business Administration (MBA) and bachelor degree in Civil Engineering, both in UiTM, Malaysia. She is particularly passionate in the areas of safety and health in the construction industry, and construction safety management within the discipline. She is also interested in research in construction project management in the context of Malaysia.

Zahra Kahvandi is an MSC in the Project and Construction Management (PCM) from MehrAlborz University (MAU). She is the gold member of the Construction and Project Management Clinic (CPMC) within the institute. Her research interests include Construction Management, Building Information Modelling (BIM) and Integrated Project Delivery (IPD).