International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 03 | March - 2023 Impact Factor: 7.185 ISSN: 2582-3930

Bimodal Implementation of Integrated Project Delivery Method and BIM: A Review

Rushabh Mehta[1], Prof. Amit N. Bhavsar[2], Dr. J.R.Pitroda[3], Navneet Sharma[4]

[1]M.Tech. (Civil) Construction Engineering & Management, BVM Engineering College, Vallabh Vidyanagar

[2]Associate Professor Construction Engineering & Management, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar

[3] Associate Professor, P.G. coordinator Construction Engineering & Management, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar

[4]Project Planner & Coordinator, Parag Techno build Pvt. Ltd.

Abstract:

Ongoing compositional, designing, and development (AEC) writing has investigated incorporated project conveyance (IPD) and building data demonstrating (BIM) as major cooperative thoughts and has in this way proposed them for further developed esteem age. In spite of the way that they are much of the time firmly interconnected, they have fundamentally been analyzed as free peculiarities. This study follows latest things in IPD and BIM writing, figures out patterns, and examines how their communication has been envisioned and addressed to further develop participation in AEC projects.

Keywords:

Integrated Project Delivery (IPD), Building Information Modelling (BIM), Early Contributions, Change Order Reduction

1. Introduction:

Construction projects are performing poorly due to delays and conflicts (D&Cs). Numerous writers have tackled them independently, yet there is still a significant grey area on how they are related to one another.[1]. According to the Construction Industry Institute's 2012 Performance Assessment of over 900 projects, only 28% of projects meet or exceed both their schedule and budget goals. To change the outcomes on complex capital projects, it is necessary to change the structure and function of project teams. Owners The construction business is undergoing major and rapid change as a result of technological advancement and owners' ongoing need for more efficient procedures that produce better, quicker, cheaper, and less competitive building projects[2]. One of the key fundamental causes of these performance issues has been identified as failings in cooperation and integration, which are essential for boosting and controlling value generation. Construction projects, however, generally include significant levels of interconnectedness inside and across companies, and one stakeholder's activities typically influence others, making successful collaboration difficult.[3]

1.1 Integrated Project Delivery:

Integrated project delivery method is defined as “project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.” [2].

IPD development is scarcely contemporary. The majority of the concepts guiding the project team's integration were developed by W. Edwards Deming while working for Toyota in the 1950s. His work on productivity optimization and improvement in management through the use of systems thinking contrasts with the present trend of fragmenting the disciplines of building. Significant consumer discontent as a result of the ongoing fragmentation of the building process, which frequently results in antagonistic interactions, has fuelled the growth of more cooperative connections, including IPD[4].

IPD is a deliberate procedure that is motivated by ongoing progress. The IPD team must develop a strategy for carrying out the project from the outset, implement the plan, assess the plan's success, and amend the plan as necessary. By using this method, early project stages are given more attention. For team members new to IPD, the early, relatively high burn rate might cause concern. The project's early stages must be managed well, but the additional early planning is a necessary side effect that will pay off as the project progresses.[5]. Despite the collaborative nature of IPD, it is the owner's responsibility to identify and organise the expectations of all owner stakeholders. In addition, owner alignment involves ensuring that management and stakeholders are aware of the IPD process, their alternatives, and their responsibilities in an IPD project. The negotiation and execution of an IPD agreement ought to be a constructive step that unites the IPD team's members behind the project's objectives and forges a commitment to its collaborative execution. To manage it well, it will take work—and probably help—but the rewards will far surpass the expense and work.[5]

The traditional methods of project delivery and contracting, which rely on separate silos of responsibility, lead to inefficiencies when work is transferred from one silo to another. Moreover, such approaches often fail to ensure that the participation of each member directly correlates with the project's success. Even if one or more participants succeed, the entire initiative can still fail. Integrated Project Delivery (IPD) marks a huge change in the business, as it destroys the storehouses of obligation, commands severe coordination among every critical member, and connections individual accomplishment to project achievement. To expand every individual's gifts and capacities, IPD deliberately redesigns member jobs, fundamental reasons, and movement groupings on a venture. Success in an integrated delivery model depends on collaboration and a project-focused approach. Rather than exceeding individual expectations, the focus is on achieving shared goals collectively. The extent to which shared objectives are accomplished determines the project's success.[2]

1.2 Building Information Modelling

Since the phrase "Building Information Modeling" or BIM was first used in the AEC sector seven years ago, it has evolved from a buzzword with a small number of early adopters to the core of AEC technology, including all facets of a building's design, construction, and use[6].

The process of developing and utilising digital models for project design, construction, and/or operation is referred to as BIM. This concept is intriguing because it broadens the scope of BIM beyond the geospatial pictures that often characterise CAD projects' representations of project geometry. This definition encompasses every piece of digital data pertaining to the project, from conception through completion and

operation. As a result, it serves as a management and communication tool for all project participants. Perhaps since the construction industry is still in the early stages of addressing this, there seems to be little effort being made in the education community to depict BIM as anything more than a 3D modelling tool[4].

Building information modelling (BIM) reception is filling in fame as of late all through all periods of a structure's life cycle, from plan to development to tasks and upkeep [6][7]. Through a virtual integration platform, BIM can boost the effectiveness of information flow. It guarantees real-time communication and updates for all members. BIM is not just a technology tool; it also participates in decision-making throughout the whole project life cycle, from the initial to the final phase[8].

BIM enjoys benefits for organizations who utilize it. Further developed creation quality, faster and more proficient information transmission, more limited project span, better partner, client, and client administrations, expanded efficiency and productivity, prior and better coordination and joint effort between all accomplices, cost following choices, early plan evaluation to guarantee project necessities are met, decreased suit, and more are among the most often referenced benefits expected for the AEC business from BIM.[9][10][6]

1.3 Integrated Project Delivery Method and BIM

Investigating the existing state of practise for both BIM and IPD is necessary in order to examine BIM as an enabling tool for IPD. Through the use of 4D and 5D models, which also include information on schedules, costs, and product data, BIM has evolved in recent years to become the standard method for organising all data on the constructed project. Early participation of the key players in the construction process through cooperative contracts like IPD may improve this cooperation.[4]

Lean construction practises and BIM may be integrated into IPD projects on an optimal platform. IPD, integrated Lean, and BIM have many similarities and overlaps, including a focus on teamwork, waste reduction, and integration. IPD provides strong support for important elements of Lean construction and building information modelling, such as early contractor participation, integrated design, and the complete life cycle approach.[11]

IPD introduces BIM as a powerful tool. However, there are several barriers and challenges to its implementation. These obstacles can be broadly categorized into two categories: process-related and people-related.[12]

2. Literature Review:

By recognizing IPD-and BIM-related subjects in the ongoing writing and analyzing the connections between the topics, as well as by explaining the idea of the cooperation among IPD and BIM. The example studies are coordinated around important points, underscoring information connections and wide patterns inside each subject as far as how IPD and BIM collaborate with each other.

2.1 Adoption of Integrated Project Delivery and Building Information Modelling

American institute of architects, (2007) describes A more legitimate and viable approach to building design, construction, and operation is evolving because to early cooperation and the use of BIM technology. In order to accept, master, and shape this new project delivery approach and to take advantage of the industry's new commercial and cultural potential.[2]

Dalui et al., (2021) suggests that the time and money formerly needed for making physical copies of designs are reduced with the use of BIM. This stated that implementing BIM inside the IPD projects will minimise the "carbon footprint" of multinational consulting companies around the globe. By integrating BIM into IPD plans, projects may be completed faster and with lower overall costs, as well as with more sustainable project results.The delay in creating coordinated 3D models when utilising BIM to link parties under an IDP agreement might be caused by unskilled BIM information writers or a lack of team expertise of integrating IPD and BIM. An opportunity between the design and construction teams may be lost due to project delivery partners', stakeholders', and supplier chains' lack of reaction to BIM concerns.[13]

Umar et al., (2015) says that all stages of a building's lifetime result in the production of a great deal of information about it, information that is both diverse and potentially endless. IPD project teams have several opportunities to use this technology advancement during the course of the project. In order to support particular possibilities, projects must install technology at various phases. It could also offer renderings of the building's architecture in time-lapse.. Because of its capacity for knowledge sharing, less information must be re-gathered and re-formatted, which improves accuracy, speeds up information transfer, and lowers the expenses related to a lack of interoperability. Integrated Project Delivery (IPD) in construction practises is advanced by its capacity to automate monitoring and assessment procedures and assist operation and maintenance operations .[14]

Karasu et al., (2022) The argument put forth is that to effect a paradigm shift in the AEC industry, there must be a well-organized structure, controlled by governmental organizations, that pushes stakeholders in the industry to adopt IPD and BIM and collaborate more. To improve financial management and tracking in IPD projects and enhance confidence among participating parties, it was recommended to integrate BIM with block chain technology. Furthermore, BIM-based IPD projects were found to perform well.[3]

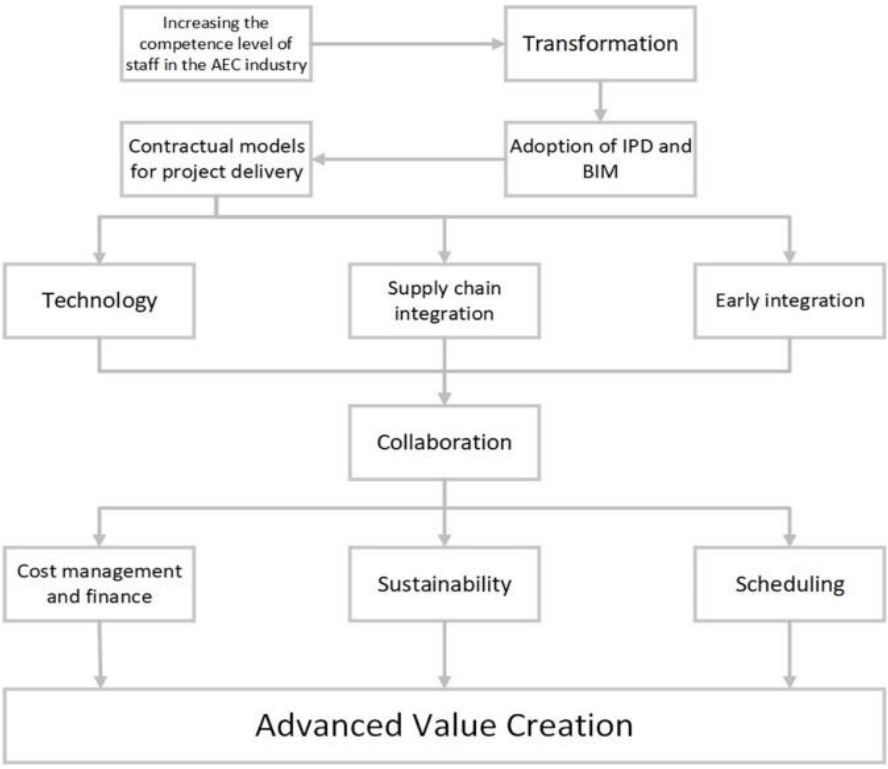

Figure 1: Synthesis of the analysis of IPD and BIM interplay[3]

Piroozfar et al., (2019) examines that early participation, teamwork, and trust are crucial components of IPD. These principles are often lacking and can hinder implementation of IPD in the UK construction industry. Multi-party agreements and BIM contractual requirements can facilitate collaboration, mutual respect, and early involvement of parties. The industry must address fragmentation and obstacles to BIM deployment such as knowledge gaps, software interoperability, and training.[15]

2.2 Importance of Team

American institute of architects, (2007) the project team is what keeps IPD going. With the primary objective of planning and executing a successful project, IPD brings project members together in an integrated team.[2]

Allison et al., (2018), Integrated Project Delivery: An Action Guide for Leaders suggests that IPD project teams have developed a reputation for being very effective and tenacious. When IPD project teams are under pressure or confronted with a difficult scenario, they are able to come together as a team to find a solution, make the necessary modifications, and rapidly be ready for the next challenge. Strong collaborative cultures that emphasise respect, accountability, openness, and psychological safety characterise IPD project teams. Regardless of whether they are among the IPD team members whose firms have placed their profit at stake, these identifiers apply to the majority of or all project participants. IPD project teams also rely on effective communication, which produces favourable results like fewer RFIs. These traits partially manifest for the IPD team as a result of the extensive project-contract negotiations and other early interactions. The deliberate efforts discussed in this part, however, which can also broaden the good IPD team culture to encompass the larger project team, improve team building. Later Work include maintaining the team throughout the project.[5]

Pease, (2018) observes that A team of partners for design and construction that is in line with the owner's specified Conditions of Satisfaction should be chosen with a clear vision for the capital project. There are several methods for choosing team members (companies &people). Each new team member's desirable characteristics and professional requirements should be taken into account during the selection process. [16]

AIA California Council, (2014) the major goal of the virtual organisation is collaboration, as explained. The project businesses and individuals are dedicated to fostering a collaborative decision-making culture. Team members are explicitly divided into interdisciplinary clusters based on the project objectives. Individual team members are responsible for contributing options to design and construction difficulties. Builders' feedback is not delayed until the building phase, when it is usually too late to improve the design.[17]

AHMAD KARZOUN, (2018) the association of IPD groups fluctuates in view of undertaking size and specialized determinations. The size of teams, their scope, leadership, and coordination are influenced by project size. Technical specifications determine team organization and overlap. The most effective teams have 4-5 members and teams larger than 12 may struggle to accomplish tasks while very small teams may lack diverse viewpoints.[18]

2.3 Contractual Terms

ConsensusDocs, (2003) The Gatherings agree that an IPD approach and rules that join Lean Development apparatuses and ideas are the best method for accomplishing the Task's targets. Trust, shared hazard and prize, agreeable direction, early commitment of the IPD Group, early explanation of Venture objectives, serious preparation, and open correspondence are the foundations of the IPD strategy. The Gatherings perceive that each Party's exhibition is firmly related to the progress of any remaining individuals from the IPD Group and consent to follow an IPD strategy that coordinates Lean Development ideas. Consequently, each Party consents to the accompanying as per the states of this Arrangement[19]

Wright, (2012) Legally binding IPD has been proposed to incorporate three parts: a multi-party understanding, a common gamble and prize part, and early commitment, all things considered. IPD is frequently placed into through a multi-party understanding however long the undertaking would last. It is endorsed by the proprietor, the modeler/engineer, the worker for hire, and different gatherings engaged with the venture. The significant goal is to boost cooperation and coordination from the outset to the furthest limit of the undertaking.[4]

American institute of architects, (2007) suggests that incorporated strategies incorporate authoritative ties that vary essentially from ordinary agreement models. Since the procedures are so differed, changing an ordinary non-incorporated agreement structure to demand coordination may be troublesome. Arranging and making contracts without past comparable agreements or standard arrangements can raise the cost of accomplishing an understanding. The AIA is by and by dealing with standard structures to help parties arrange and consent to an IPD arrangement.[2]

Pease, (2018) explains that typical projects place the owner in the centre of an antagonistic arrangement between the teams. The teams are organised under a single contract with a shared risk and reward structure in IPD projects. Success is determined by the final product of the project, not by the individual contributions of each team member. In difficult circumstances, when a typical contract structure might lead the team to disintegrate, this alignment of incentives helps the team stay together. IPD Contracts Have Multiple Components: A shared contingency, guaranteed, audited costs, multiple signatories, profit at risk, costs for design and construction, and shared savings are all required.[16]

AHMAD KARZOUN, (2018) The foundation of fulfilling IPD goals is multi-party agreement among essential players, who sign a single contract outlining their respective roles, responsibilities, liabilities, and rights. Each party recognises its relationship with the other parties as a single agreement is created. Trust is necessary for multi-party agreements since both the overall success of a project and each individual one largely depends on the amount of participation from each participant, which implies that all participants must work together as a team to achieve the intended goals. Deep planning, rigorous team building, and cautious negotiation are required for MPA. These processes take place in the initial phases of project design, even though they may be expensive. It is best if the participants have worked together before.[18]

2.4 Shared Risk and Reward

Elghaish F.K.A., (2020) Sharing risk/reward depends on finishing all project activities, but managing the financial data presents a number of challenges, including keeping everyone updated on all profits/risks data..[21]

AIA California Council, (2014) explains that this is the legal connection between profit based on a predetermined result and change order restrictions. The business model becomes a requirement rather than a desire when both of these characteristics are included in an agreement that is legally binding. This is one of the ways that real IPD differs from other collaborative strategies, like partnering, that aim to alter behaviour but can be dropped mid-project since they are not bound by a contract. [17]

NASFA et al., (2010) Some owners are employing a novel, alternative strategy with success when hiring project teams and providing incentives for their cooperation. They are utilising a "multi-party contract," which enables many parties to collectively agree to a shared set of terms and expectations, which is a type of contract that incorporates more than two parties to the agreement. The agreement must be signed by at least the owner, the architect, and the contractor. In rare situations, other project team members who are deemed essential to the project's success may also be included. Along with everyone signing the same contract, this arrangement is unusual in that risks are shared and pay is based on the team's performance on the project as a whole rather than the performance of any one participant.[22]

Kent & Becerik-Gerber, (2010) Current IPD contracts prioritize collaboration and overall project success over individual team member success. They combine risks and rewards, promoting collaboration to achieve goals. This is in contrast to traditional projects where parties limit their own risk. Objectives typically relate to cost, time, and quality indicators. A risk is covering budget overages from overhead and profit, but a bonus is possible if the project is under budget.[20]

Ashcraft, (2011) explains that the IPD strategy requires collaborative project control since the risk and reward must be distributed among all members of core project teams. The pay system frequently depend on all inclusive achievements as well as two expense lines: the objective expense, which lays out the expense gauge, and the settled upon benefit in danger rate. Project execution shows the level of progress is situated between the two lines, which connotes that the excess ought to likewise be shared, and on the off chance that a venture achieves underneath its objective expense, it implies the expense saving % ought to be split between key members. At long last, the client is just answerable for covering the immediate costs assuming the presentation shows that this sum outperforms the benefit in danger line.[23]

2.5 Cost & Finance

Elghaish & Abrishami, 2020 Fair profit sharing is a major flaw in IPD cost management, and accurate cost estimating at the start of projects is lacking. Combining BIM with EVM, ABC, and block chain can enhance cost estimates and simplify financial transactions, but they alone cannot guarantee effective cost management.[24][25]

Harrison and Thurnell (2015) seen that consolidating five-layered BIM with four-layered BIM empowers the best construction of IPD's immediate, backhanded, and above costs. Additionally avowed that IPD works with full abuse of 5D BIM. Building trust between the gatherings included was energized through the reconciliation of BIM and block chain advancements in IPD projects by expanding control and following of monetary exchanges.[26]

Ma et al. (2017) claimed that IPD is effective in removing change orders and that BIM helps reveal change orders prior to the construction stage. They admitted that one of the main reasons for cost overruns is modification orders. The majority of the papers in this cluster came to the conclusion that BIM promotes

IPD by streamlining information processing and fostering trust and collaboration, especially when compared to ABC, EVM, and block chain technologies. [27]

American institute of architects, (2007) IPD emphasizes life cycle and sustainability and defines project cost at the start. Quantity survey and design link can help with cost estimation and management. Rethinking project stages can make design choices more efficient and affordable. The "MacLeamy curve" in figure 2 shows design decisions should be made earlier in the project. It was initially mentioned in "Collaboration, Integrated Information, and the Project Lifecycle in Building Design, Construction, and Operation" by the Construction Users Roundtable.

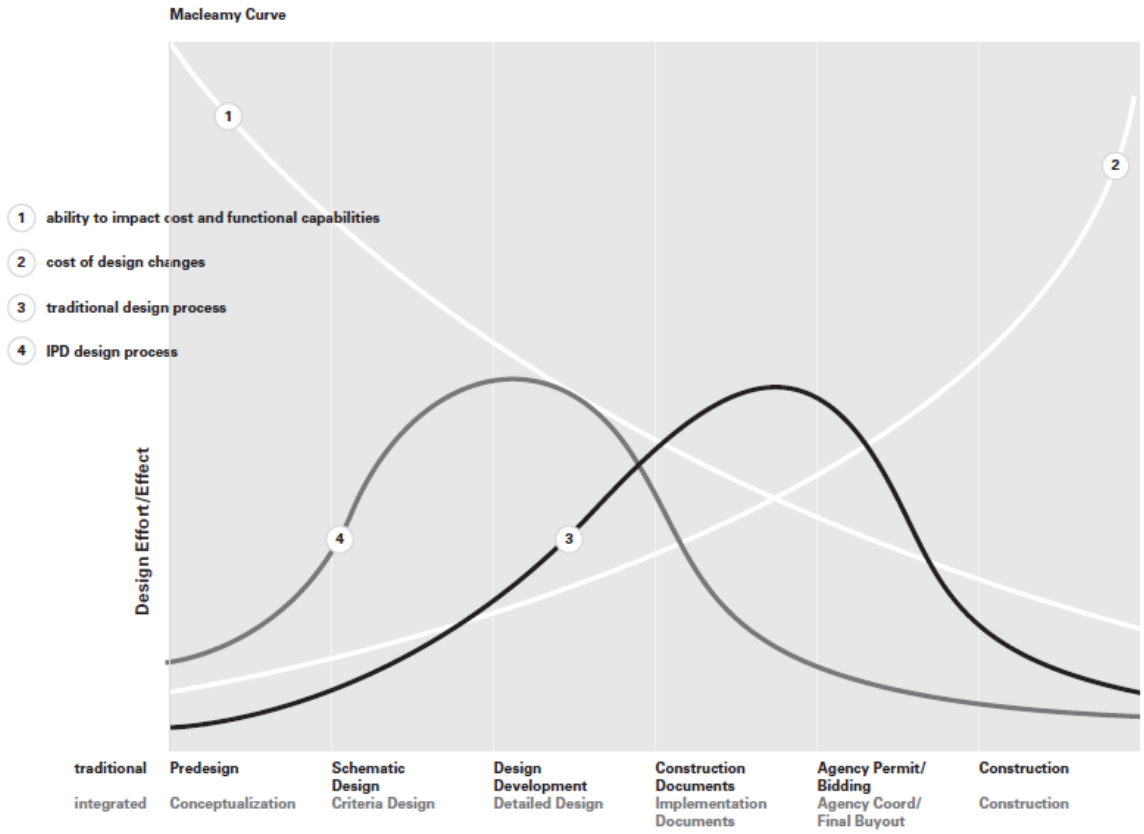

Figure 2. MacLeamy Curve[2]

Major Findings:

This work contributes in two vital ways to the current comprehension of IPD, BIM, and their cooperation. IPD and BIM reception, the meaning of group legally binding models for project conveyance, cost administration and money, shared risk and prize, and group building were the main areas of IPD and BIM research that were explained utilizing a survey to bunch relevant papers from the current IPD and BIM writing.

In order to highlight the versatility of IPD and BIM, technical and sustainable approaches were investigated in addition to their use as collaborative techniques. The majority of the studies that were assessed supported the integration of IPD and BIM, but a few also highlighted the need for additional strategies including ABC, EVM, and target value design to boost cost management effectiveness. Another topic that attracted a lot of discussion was the use of IPD and BIM. Academic dissatisfaction with the industrial adoption of IPD and

BIM, which is projected to be a hot topic for the foreseeable future, has primarily focused on the concomitant obstacles and challenges. A significant number of excellent papers in our review highlighted the lack of attention given to emerging ideas like IPD and BIM in the AEC curriculum, as indicated by the general lack of grasp of these approaches.[28][3][2][29]

It is evident from the smaller clusters that the subject of transformation requires greater study. Surprisingly few studies have focused on the subject of transformation in the context of IPD and BIM, despite the fact that the AEC industry is under pressure to adapt and is underperforming other sectors in terms of productivity. We argue that the dominant conventional paradigm can be changed to IPD- and BIM-enabled collaborative projects through a systematic transition approach. IPD and BIM research only has a small number of publications that address the core issue of scheduling, which is surprising given how frequently construction projects have delays.

IPD may be performed legally without BIM, yet BIM cooperation yields superior results in AEC projects. IPD or BIM adoption on an individual basis only yields a limited set of advantages. In a summary, the principles that have been introduced increase value generation through the concurrent deployment of IPD and BIM. Themes and their connections to enhanced value creation came from studies of the interactions between IPD and BIM in recent literature.

On the basis of a thorough analysis of recent literature, this study contends that IPD and BIM share a number of fundamental principles. It is also obvious that the adoption of IPD and BIM is complementary. Everyone's success is also intimately related to that of the other. This connection does not, however, restrict their utilisation separately from one another.

Due to its emphasis on the integrated process and BIM as a method and technology, IPD stands out among the other project delivery forms in our sample when increased value generation through cooperation is the goal. Academics are working to find solutions to these issues since there are requirements for IPD and BIM adoption at the industrial and organisational levels.[30][31]

The AEC sector is shifting towards more collaborative, sustainable, technology models like IPD and BIM, but their understanding and execution may differ by country due to regulations and public sector goals. IPD preconditions may take years to meet.

Conclusion:

The new work adds to our understanding of IPD, BIM, and how they interact in two important ways. The first areas of IPD and BIM research that were clarified using a review to group pertinent papers from the existing IPD and BIM literature included IPD and BIM adoption, the importance of team contractual models for project delivery, cost management and finance, shared risk & reward, and team building. Many perspectives on the interactions between IPD and BIM were obtained and explored in this analysis of contemporary research. Despite the fact that our results confirm the lack of unanimity on this issue, IPD and BIM seem to support and complement one another. Our study demonstrates that project owners' efforts to promote collaborative behaviour are preferred to random emergence, even though it is acknowledged that views towards collaboration are influenced by national legislation and public agencies' intentions. The topics that have been discovered emphasise future developments and trends that better understand the characteristics of IPD and BIM as well as suitable research frameworks. Although the shift to a more collaborative approach is significantly influenced by project owners, collaborative concepts still need to be

produced and verified since construction companies are compelled to meet recognised needs. Only by teaching the industry how to fully utilise IPD and BIM can this vicious cycle be halted, and as several studies have demonstrated, doing so will depend on raising the level of staff competency in the AEC sector.

References:

[1] J. Tariq and S. Shujaa Safdar Gardezi, "Study the delays and conflicts for construction projects and their mutual relationship: A review," *Ain Shams Eng. J.*, vol. 14, no. 1, 2023, doi: 10.1016/j.asej.2022.101815.

[2] AMERICAN INSTITUTE OF ARCHITECTS, "Integrated Project Delivery: A Guide," *Am. Intitute Archit.*, vol. 1, no. 1, p. 62, 2007, [Online]. Available: https://help.aiacontracts.org/public/wp-content/uploads/2020/03/IPD_Guide.pdf

[3] T. Karasu, K. Aaltonen, and H. Haapasalo, "The interplay of IPD and BIM: a systematic literature review," *Constr. Innov.*, 2022, doi: 10.1108/ci-07-2021-0134.

[4] J. A. Wright, "The integration of building information modeling and integrated project delivery into the construction management curriculum," *ASEE Annu. Conf. Expo. Conf. Proc.*, 2012, doi: 10.18260/1-2--22074.

[5] M. Allison, H. W. Ashcraft, R. Cheng, S. Klawans, and J. Pease, "Integrated Project Delivery: An Action Guide for Leaders," pp. 1–154, 2018, [Online]. Available: https://www.ipda.ca/site/assets/files/2154/ipd_guide_pankow_ipda_cidci_web.pdf

[6] C. Eastman, P. Teicholz, R. Sack, and K. Liston, *BIM Handbook, a Guide to Building Information Modelling 2nd ed.* 2011.

[7] A. Ahmad M. Alwafi, "Integrated Project Delivery Contract Model in Supporting BIM-Based Construction Projects," *Am. J. Civ. Eng. Archit.*, vol. 10, no. 2, pp. 82–92, 2022, [Online]. Available: http://pubs.sciepub.com/

[8] A. H. Abd Jamil and M. S. Fathi, "Contractual challenges for BIM-based construction projects: a systematic review," *Built Environ. Proj. Asset Manag.*, vol. 8, no. 4, pp. 372–385, 2018, doi: 10.1108/BEPAM-12-2017-0131.

[9] A. A. Latiffi, S. Mohd, N. Kasim, and M. S. Fathi, "Building Information Modeling (BIM) Application in Malaysian Construction Industry," vol. 2, no. June 2014, pp. 1–6, 2013, doi: 10.5923/s.ijcem.201309.01.

[10] Y. Arayici and J. Tah, "Towards building information modelling for existing structures," *Proc. 11th Int. Conf. Civil, Struct. Environ. Eng. Comput. Civil-Comp 2007*, 2007, doi: 10.4203/ccp.86.76.

[11] B. Dave, L. Koskela, and A. Kiviniemi, *Implementing Lean in construction*. 2013. [Online]. Available: http://assets.highways.gov.uk/specialist-information/knowledge-compendium/2011-13-knowledge-programme/Lean and the Sustainability Agenda.pdf

[12] H. Hajarolasvadi, "Barriers of Implementation of Integrated Project Delivery in IRAN Barriers of Implementation of Integrated Project Delivery in IRAN," no. February, 2014.

[13] P. Dalui, F. Elghaish, T. Brooks, and S. McIlwaine, "Integrated project delivery with BIM: A methodical approach within the UK consulting sector," *J. Inf. Technol. Constr.*, vol. 26, no. October,

pp. 922–935, 2021, doi: 10.36680/J.ITCON.2021.049.

[14] U. A. Umar *et al.*, "4D BIM application in AEC industry: Impact on integrated project delivery," *Res. J. Appl. Sci. Eng. Technol.*, vol. 10, no. 5, pp. 547–552, 2015, doi: 10.19026/rjaset.10.2462.

[15] P. Piroozfar, E. R. P. Farr, A. H. M. Zadeh, S. Timoteo Inacio, S. Kilgallon, and R. Jin, "Facilitating Building Information Modelling (BIM) using Integrated Project Delivery (IPD): A UK perspective," *J. Build. Eng.*, vol. 26, p. 100907, 2019, doi: 10.1016/j.jobe.2019.100907.

[16] J. Pease, "Lean IPD," *Verkkosivu*, p. Viitattu 13.11.2018, 2018, [Online]. Available: https://leanipd.com

[17] AIA California Council, "Integrated Project Delivery : an Updated," *Am. Inst. Archit.*, pp. 1–18, 2014, [Online]. Available: https://aiacalifornia.org/wp-content/uploads/2014/08/AIACA_IPD.pdf

[18] AHMAD KARZOUN, "EVALUATION OF INTEGRATED PROJECT DELIVERY METHOD IMPLEMENTATION IN OPTIMIZING CONSTRUCTION PROJECTS," *2018*, 2018.

[19] ConsensusDocs, "STANDARD MULTI-PARTY INTEGRATED PROJECT DELIVERY (IPD) AGREEMENT This," no. 3627, 2003.

[20] D. C. Kent and B. Becerik-Gerber, "Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery," *J. Constr. Eng. Manag.*, vol. 136, no. 8, pp. 815–825, 2010, doi: 10.1061/(asce)co.1943-7862.0000188.

[21] Elghaish F.K.A., "An automated IPD cost management system — University of Portsmouth," 2020, [Online]. Available: https://researchportal.port.ac.uk/en/studentTheses/an-automated-ipd-cost-management-system

[22] NASFA, COAA, APPA, AGC, and AIA, "Integrated Project Delivery For Public and Private Owners," *Collab. Natl. Assoc. State Facil. Adm. Constr. Owners Assoc. Am. Assoc. High. Educ. Facil. Off. Assoc. Gen. Contract. Am. Am. Inst. Archit.*, pp. 1–45, 2010, [Online]. Available: https://coaa.org/Documents/Owner-Resources/Industry-Resources/IPD-for-Public-and-Private-Owners.aspx

[23] H. J. Ashcraft, "Negotiating an integrated Project Delivery," *Constr. Lawyer*, vol. 31, no. 17, 2011, [Online]. Available: https://www.hansonbridgett.com/-/media/Files/Publications/NegotiatingIntegratedProjectDeliveryAgreement.pdf

[24] F. Elghaish and S. Abrishami, "Developing a framework to revolutionise the 4D BIM process: IPD-based solution," *Constr. Innov.*, vol. 20, no. 3, pp. 401–420, 2020, doi: 10.1108/CI-11-2019-0127.

[25] F. Elghaish, S. Abrishami, and M. R. Hosseini, "Integrated project delivery with blockchain: An automated financial system," *Autom. Constr.*, vol. 114, no. June, 2020, doi: 10.1016/j.autcon.2020.103182.

[26] P. E. D. Love, J. Zhou, D. J. Edwards, Z. Irani, and C. P. Sing, "Off the rails: The cost performance of infrastructure rail projects," *Transp. Res. Part A Policy Pract.*, vol. 99, pp. 14–29, 2017, doi: 10.1016/j.tra.2017.02.008.

[27] J. Ma, Z. Ma, and J. Li, "An IPD-based incentive mechanism to eliminate change orders in construction projects in China," *KSCE J. Civ. Eng.*, vol. 21, no. 7, pp. 2538–2550, 2017, doi: 10.1007/s12205-017-0957-3.

[28] Robert G. Cooper, “기사 (Article) 와 안내문 (Information) [,” *Eletronic Libr.*, vol. 34, no. 1, pp. 1–5, 1976.

[29] D. Forgues and B. Becerik-Gerber, “Integrated project delivery and building information modeling: Redefining the relationship between education and practice,” *Int. J. Des. Educ.*, vol. 6, no. 2, pp. 47–56, 2013, doi: 10.18848/2325-128x/cgp/v06i02/38413.

[30] L. Zhang and F. Li, “Risk/reward compensation model for integrated project delivery,” *Eng. Econ.*, vol. 25, no. 5, pp. 558–567, 2014, doi: 10.5755/j01.ee.25.5.3733.

[31] K. Govender, J. Nyagwachi, J. J. Smallwood, and C. J. Allen, “The awareness of integrated project delivery and building information modelling - facilitating construction projects,” *Int. J. Sustain. Dev. Plan.*, vol. 13, no. 1, pp. 121–129, 2018, doi: 10.2495/SDP-V13-N1-121-129.