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Integrated project delivery in the AEC sector: A four-step systematic literature review

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Abstract
Considering low productivity rates and insufficient collaboration within the AEC sector; some new methods like integrated project delivery (IPD) have been developed to enhance projects' life cycles. This search aims to examine 207 studies thoroughly by using the PRISMA Statement and present detailed descriptive statistics, the most common definitions, principles, benefits, and barriers of IPD. A comprehensive definition of IPD is provided, and the main and optional principles for IPD implementation are suggested. Another purpose of this research is to compile studies examined performance outcomes of IPD in 7 performance areas, as well as performance comparisons of IPD with traditional project delivery systems (PDSs). A systematic search was conducted in 2 extensive databases: Scopus and Web of Science (WoS). Bibliometrix and VOSviewer softwares are used in the analysis. According to the performance evaluations in the literature, IPD has no superiority over traditional PDSs concerning cost performance, and no significant differences in HSE performances are found. On the other hand, it is asserted in the literature that IPD has a slightly superior schedule performance over traditional PDSs, and IPD has superior performances in communication, quality, change management, and business areas compared to traditional PDSs.

Keywords
Bibliometric search, Integrated project delivery, Performance outcomes, Scientometric analysis, Systematic literature review.

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1. Introduction

Academics and experts in the Architecture, Engineering, and Construction (AEC) sector have been looking for answers to the challenges faced within the sector. Following these investigations in the industry, various innovative methods, including lean management, along with emerging technologies like building information modeling (BIM), have been adopted in the AEC industry. However, there are still inadequacies in integrating new technologies and approaches into contract types, decreasing wastes, improving cooperation, and enhancing productivity. IPD offers an effective method to tackle the challenges that conventional project delivery systems present.

IPD provides several advantages, including enhanced collaboration, early stakeholder involvement, improved productivity, fewer conflicts, and better budget and time management (Durdyev et al., 2020; Sun et al., 2015). Its adoption has been on the rise in certain developed countries, effectively producing enhancements in various construction initiatives (Khemlani, 2009; Matthews & Howell, 2005). However, the practice of IPD remains limited globally, and there are obstacles to its implementation. Recently there has been much discussion about several obstacles to IPD implementation, like legal barriers, resistance to change, poor communication, and a lack of IPD experience among stakeholders (Kahvandi et al., 2018). As far as we are aware, there has been limited investigation into the context and degree of integration within the construction sector (Gomez et al., 2018). For this reason, systematic literature reviews are required to synthesize current research findings, identify research frontiers, and draw on future initiatives in relation to the construction sector.

On the basis of the evidence currently available, it seems fair to suggest that analysis of the advantages and promising sides of IPD is an encouraging field to research. To comprehend the current debate on IPD, we aimed to examine the existing research regarding the consequences of utilizing IPD as a delivery method. It was also aimed to use a systematic review approach to review the IPD literature, provide descriptive statistics, review and classify definitions, principles, benefits, and barriers of IPD. This research aims to analyze and categorize prior studies by applying the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement, as well as to evaluate the performance outcomes of IPD. Considering the lack of industry-wide agreed-upon definition of IPD, a comprehensive definition of IPD is provided in this study. Moreover, the main principles of IPD, optional and accelerator principles for IPD implementation are suggested for practitioners and researchers.

This systematic review indicates that studies related to IPD are relatively recent, and there are a few articles related to IPD before 2000. Further, it can be said that the United States has the highest number of articles related to IPD, and IPD studies are insufficient in many countries, including Türkiye. Having no comprehensive study in the field of IPD is the main reason for the unfamiliarity of project stakeholders with such a project delivery system (PDS) in the construction sector (Bach, 2014).

As a result of analyzing performance outcomes of IPD in 7 performance areas, it can be concluded that IPD has no superiority over traditional PDSs concerning cost performance, however, IPD could provide a significant improvement in cost management at least by eliminating cost overruns. Moreover, IPD has a somewhat better performance in scheduling compared to conventional PDSs, and IPD outperforms traditional PDSs in communication area across all evaluations. In addition, most of the evaluations assert that IPD has superiority over traditional PDSs regarding quality performance, and all of the related evaluations indicate that IPD has superiority over traditional PDSs regarding change management performance. Additionally, IPD has positive and superior business performance in all of the related evaluations, and it is indicated that IPD provides increased market opportunities, fewer claims, pleased owner, long-term reliability. Lastly, there are only

4 evaluations regarding HSE (Health, Safety, and Environment) performance among 33 identified evaluations, and no significant differences in HSE performances are found.

This study examines the subsequent research questions:

- How are performance outcomes of IPD implementations in 7 performance areas (cost, time, quality, communication, change management, business, and HSE)?
- Which researches have been done explicitly on IPD in the AEC sector, and are the performance results obtained from IPD cases in the literature parallel with the projected advantages of IPD in the literature?
- What are the most common definitions, principles, benefits, and barriers of IPD?
- What are the descriptive statistics (years, authors, countries, etc.) of IPD studies?
- How is the collaboration among the authors and the countries?

2. Research method

This research involves a four-phase methodical literature evaluation that includes bibliometric search, scientometric analysis, comprehensive literature review, and discussion on performance outcomes of IPD. The process of the systematic literature review is depicted in Figure 1. The systematic review approach of the PRISMA Statement is used in this study. The PRISMA Statement was developed to improve consistency and quality of systematic reviews (Moher et al., 2009), and it has a quite clear methodological approach (Shamseer et al., 2015). This approach is selected to strengthen the methodological quality and reliability of the review.

A methodical review of IPD studies was performed in June 2021 utilizing 2 extensive databases, Scopus and WoS. These databases hold a significant number of publications, including journals and books, and both are regarded as reputable sources in the scientific community. Bibliometric research approaches were used to analyze the layout and quality of performance outcomes of IPD research. The retrieved data was investigated by employing the software VOSviewer, the Online Analysis Platform of Literature Metrology (http://bibliometric.com/) and Bibliometrix, a freely available resource for quantitative research in scientometrics and bibliometrics, to examine and forecast the trends in this area. In the last two steps, a comprehensive literature review and discussion on performance outcomes of

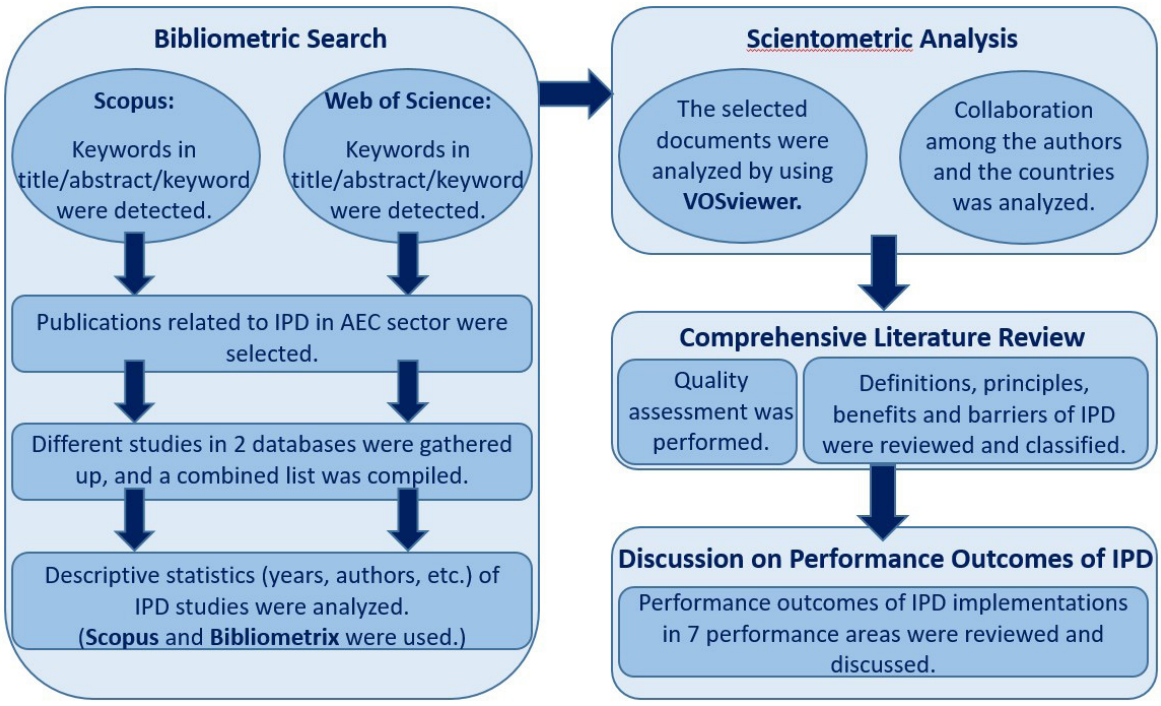

Figure 1. *Workflow of the systematic literature review.*

IPD implementation were performed after a quality assessment by using Scimago Journal Rank (SJR).

3. Bibliometric search

In the first step, the bibliometric search is performed in 4 phases: identification, screening, selecting and analysis.

3.1. Identification of studies

There is no industry-wide agreed-upon definition of IPD, and some principles of IPD, such as early involvement and collaborative engagement of stakeholders, have been used in the AEC sector in the name of relational contracting or alliancing. As a result, it was considered that relying on precise wording might lead to overlooking certain pertinent documents, so alternative phrasing was utilized in the query string to capture all publications associated with IPD. The keywords listed below were queried in the title, abstract, and keyword sections: integrated project delivery, integrated contract, integrated contracts, IPD, Pure IPD, multi-party contract, multi party contract, multi-party contracting, relational contracting, alliance contract, alliancing.

A systematic search was conducted in June 2021 by using the stated keywords in 2 databases, Scopus and WoS. Firstly, the specified keywords were explored in title/abstract/keyword fields in Scopus, and 1,074 studies were detected. Then, subject areas not related to the AEC sector such as biology, medicine, mathematics were excluded, and number of results was decreased to 431 in Scopus. Further, documents with undefined authors and source titles were excluded, and number of results was 416 in Scopus. Further, same procedure was followed in WoS, and 487 studies were detected in WoS database which differs in the interface and commands.

3.2. Screening of studies

A systematic review's eligibility screening step entails establishing criteria that assess which primary research studies uncovered during searches are pertinent for addressing the research questions (Frampton et al., 2017). The criteria for inclusion in this study are determined by the Guidelines for Systematic Reviews in Environmental Management developed by the Collaboration for Environmental Evidence (CEE). Before beginning eligibility screening, duplicated publications that were common in search results were removed as a preliminary step. Furthermore, eligibility screening can be used to implement a variety of filters at these various phases of reading. According to CEE recommendations, at least two filters should be used: (a) a first reading of titles and abstracts to efficiently remove articles which are clearly irrelevant, and (b) assessment of the full-text version of the article (CEE, 2013).

Titles, abstracts, and introductions (also full-texts in necessary cases) of the publications in the searches were reviewed, and studies not related to IPD such as integrated product development and improved passive damping were removed from the data sets. Then, 184 out of 416 publications from Scopus database and 73 out of 487 publications from WoS database were found relevant. Further, 73 documents selected from WoS database were examined, and 12 publications were excluded due to being a book or a book series, and 38 publications were excluded due to existing in the data set of last search in Scopus. A flow diagram for the identification of studies was presented in Figure 2 by using PRISMA 2020 flow diagram provided by Page et al. in 2021.

3.3. Selection criteria

The criteria outlined below were employed in the selection of publications.

- There was no time constraint, and all related studies in the databases were considered to identify all relevant publications on the subjects related to IPD.
- Only articles were included in the search because their research methodologies could easily be examined. Other types of documents such as conference papers, books, reports were excluded because their quality and eligibility could

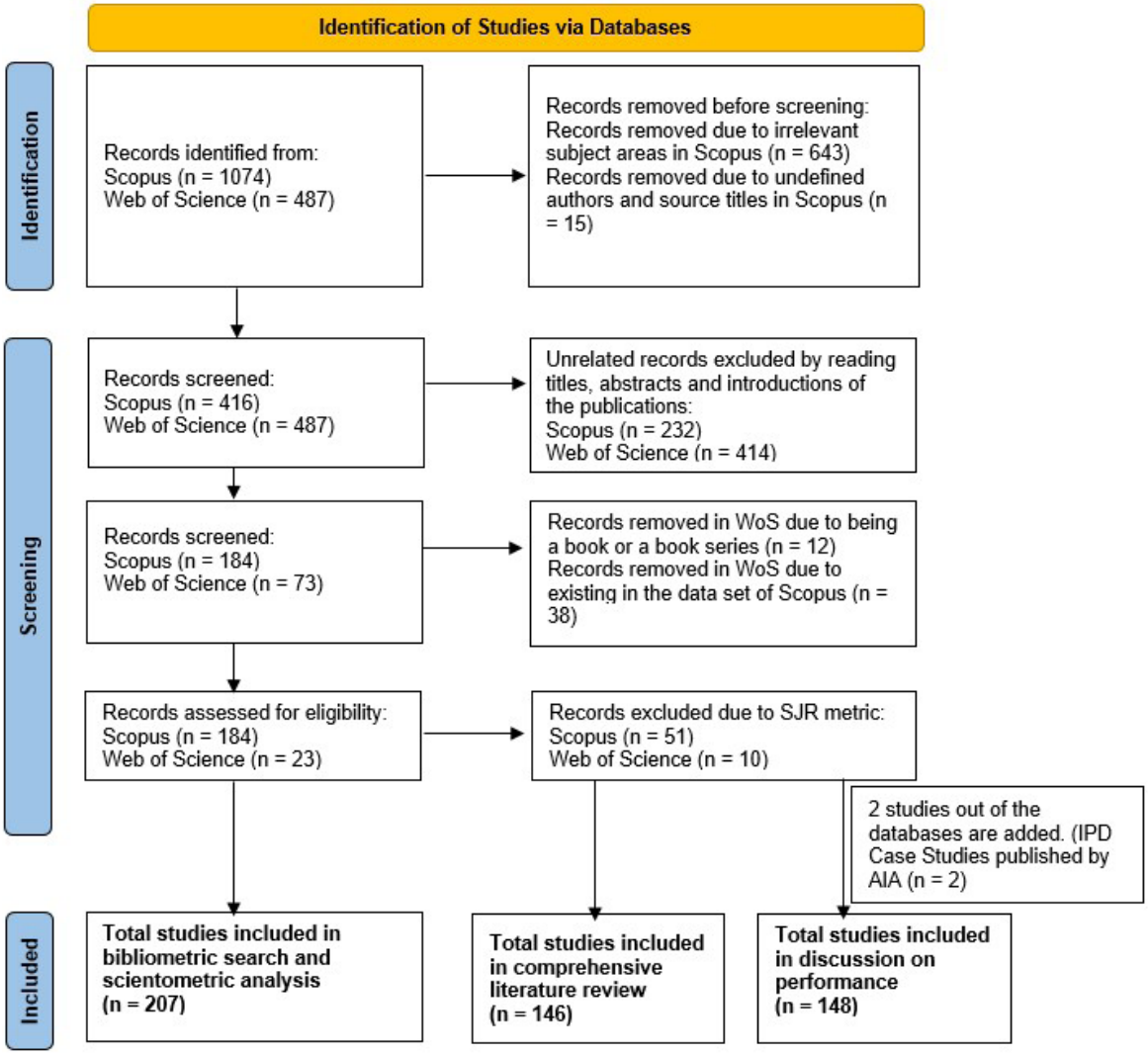

Figure 2. *PRISMA flow diagram for identification of studies.*

not be measured effectively.

- Only studies in the subject areas of engineering, construction, architecture, business, management, and accounting were included. Subject areas not related to the AEC sector such as biology, medicine, mathematics were excluded. Moreover, publications with undefined subject areas were excluded.
- Documents with undefined authors and source titles were excluded because these publications could not be analyzed properly.
- Despite using the mentioned criteria in the searches, some irrelevant documents, which were not related with the determined keywords, were identified in the data sets by reading titles, abstracts, and introductions (also full-texts in necessary cases) of the publications. These irrelevant documents were removed from the data sets.

3.4. Analysis and results

The analysis is done by using VOSviewer, R-based Bibliometrix and Scopus Analyst. This research employs various bibliometric metrics such as citation analysis, bibliographic coupling, and co-occurrence analysis to illustrate the development of IPD. The analysis begins with describing the main bibliometric statistics to gain a sense of the relative standing of the IPD in the AEC sector. It could be essential to emphasize that studies included in the bibliometric and scientometric analyzes were identified by using different wording such as integrated project delivery, integrated contract, integrated contracts, IPD, Pure IPD, multi-party contract,

multi party contract, multi-party contracting, relational contracting, alliance contract, alliancing.

The annual publication numbers and citation information of the different journals/authors were analyzed using the online bibliometric platform, Bibliometrix, and Biblioshiny application for Bibliometrix. The bibliographic statistics of 207 studies published in 62 different sources between 1975 and 2021 show that the average number of citations per article is 31.94, and per year per article is 3.272. The reviewed studies were published by a total of 426 authors, with 582 author appearances. The number of single-authored documents is 43, and these studies were published by 32 authors. Documents per author is 0.486, and the average number of co-authors per publication is 2.81, indicating that this field's articles are the outcome of collaborative research efforts.

The articles were also analyzed in terms of authors and citations, and there were 9 authors who have more than 4 articles related to IPD. During the reporting period, these authors contributed 64 papers, accounting for 30.92 percent of the total publications output with 2652 citations. The publication count revealed Ling, F. Y. Y. as the first in the list, with 11 publications and the highest h-index (11). For his 9 papers, Kumaraswamy, M. M. has the most citations (514). Lahdenpera, P. and Rahman, N. M. are the 3rd authors with the most publications (8), and Rahman, N. M. is the 2nd most cited author with 512 total citations. The authors' h-index measures both the productivity and citation impact of the publications of a scientist or scholar (Hirsch, 2005). The index derives from a collection of the scientist's most frequently cited works and the count of citations they have garnered in various other publications.

Articles related to IPD were also examined by year. The study identification process was completed on June 5-6, 2021, and publications after this date are not included in this study. During the first period (1975–2000), the total number of papers is 7, and the first article was published in 1975 by Warszawski, A. The period 2001–2010 counts 53 papers. The last years (2011–2021) is the most productive period with 147 contributions. There are more than 10 articles per year after 2013, and 19 articles on topics related to IPD were published in 2020.

Based on the review regarding countries, United States has the highest number of articles (53), and these articles are at the forefront in supporting understanding IPD among the other countries. Australia was the 2nd country with the most publications in the field of IPD with 35 articles. United Kingdom was in third place with 27 publications. Only 1 article affiliated to Türkiye was detected that was performed by applying the explained criteria in two databases.

The top five journals preferred by researchers in the field of IPD are Journal of Construction Engineering and Management (23 publications), Journal of Construction Management and Economics (15), Lean Construction Journal (14), Journal of Engineering, Construction and Architectural Management (13), and International Journal of Project Management (11). During the reported period, Journal of Construction Management and Economics received 1687 citations, followed by Journal of Construction Engineering and Management which received 1439 citations. With the help of Bibliometrix R package, Journal of Construction Engineering and Management had the highest h-index (18), m-index (0.69), and g-index (23) values.

Clusters of keywords considered to be themes, whose density and centrality can be used to classify and map themes in a two-dimensional diagram. The KeyWords Plus field is used in the thematic map (Figure 3) that examines topics based on the quadrant in which they are positioned. The Keywords Plus field, unlike the authors' keywords, is normalized. The Keywords Plus terms can encapsulate the content of an article with enhanced depth and diversity (Della et al., 2021). The upper-right section illustrates the motor themes that are defined by significant centrality and density. The motor theme in this analysis is relational contracting. With regard to the upper-left quadrant, it

demonstrates high density themes but unimportant external links, which are highly developed and isolated themes (low centrality). In this quadrant, architectural design and BIM are nish themes. In the lower-left quadrant are themes that are either emerging or declining. In this analysis, the theme of contracts is emerging. It is interesting to note that one of the most recurring words associated with the theme of contracts is "industrial management". Finally, the lower-right quadrant shows the themes that are basic and transversal. These themes address general issues that cut across the field's various research areas. The themes that emerge in this area are project management and construction industry.

4. Scientometric analysis

In the next phase, the selected studies were evaluated using VOSviewer software (version 1.6.16), conducting analyses on co-authorship and keyword co-occurrence. VOSviewer is a widely used tool for science mapping that helps generate maps from network data and allows for the visualization of those maps (Van Eck & Waltman, 2019). The analysis employed a fractional counting approach, as the creators of VOSviewer recommended utilizing this methodology over the traditional full counting method (Van Eck & Waltman, 2014).

4.1. Scholars and collaborations

An analysis of co-authorship was performed to identify the topics related to IPD that the researchers focused on and their collaborative efforts. In this evaluation, the minimum required number of documents and the minimum citation count for an author were set to 1 and 0, respectively. As a result of this selection, 425 of 425 scholars met the requirement, and all of the authors were illustrated in Figure 4. Node and font sizes are proportional to the number of publications, and link thickness refers to the number of publications co-authored. Ling, F. Y. Y. is the most productive researcher in the identified field and has the strongest linkage, and Kumaraswamy, M. M. is the second author in strong collaboration with colleagues.

4.2. Keywords analysis

An analysis of co-occurrence for author keywords was performed to outline research themes and illustrate core content. The minimum frequency for a keyword was set to 1, and all 491 keywords fulfilled this criterion. Commonly used keywords are illustrated in Figure 5. The size of the nodes and fonts reflects the frequency of keyword usage, and most frequently used keywords are "integrated project delivery", "relational contracting", "collaboration", "integrated project

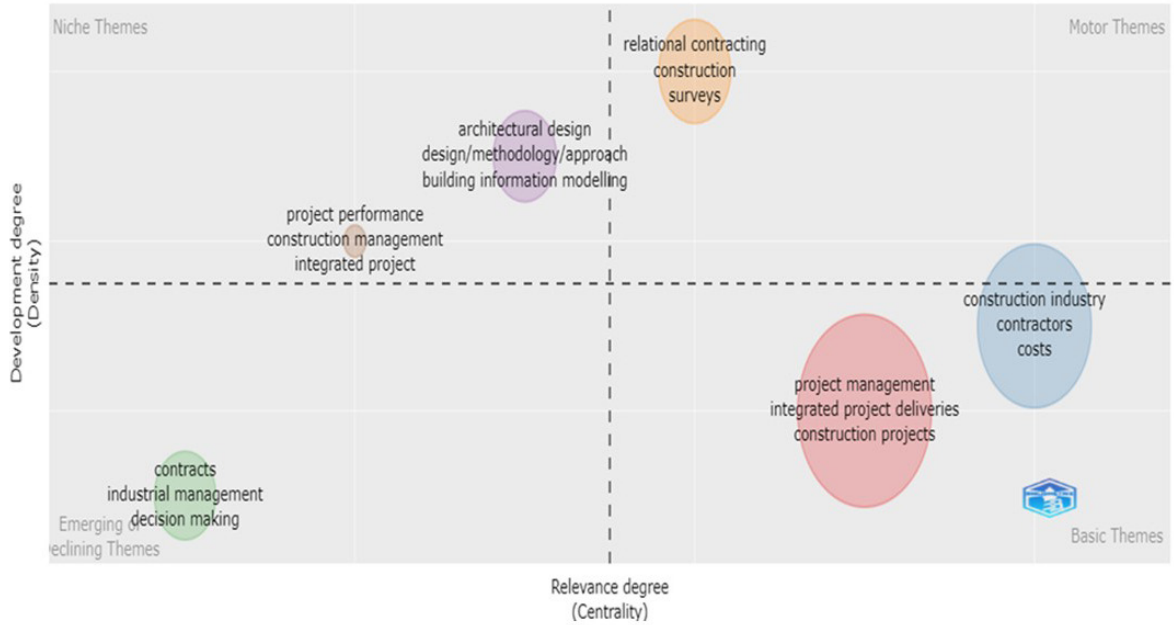

Figure 3. *Thematic map.*

delivery (ipd)", "partnering", "alliancing", and "construction industry". Furthermore, keywords are categorized according to how often they are used together, and these categories, referred to as clusters in VOSviewer, are assigned different colors.

4.3. Collaboration among the countries

Collaboration among the countries was analyzed, and the minimum required number of documents and the minimum citation count for a country were designated as 1 and 0, respectively. As a result, 41 of 41 countries met the requirement. Six countries, Türkiye, Egypt, Germany, India, Indonesia, and Iraq, do not have any joint publications with other countries in the field of IPD per the research criteria. Australia, United States, Hong Kong, and United Kingdom have the strongest linkage among the other countries, and these countries are dominant in terms of international collaboration.

5. Comprehensive literature review

In the third step, a comprehensive literature review was performed, and definitions, principles, benefits, and barriers of IPD were reviewed and classified.

The relevant articles were identified by applying the explained criteria,

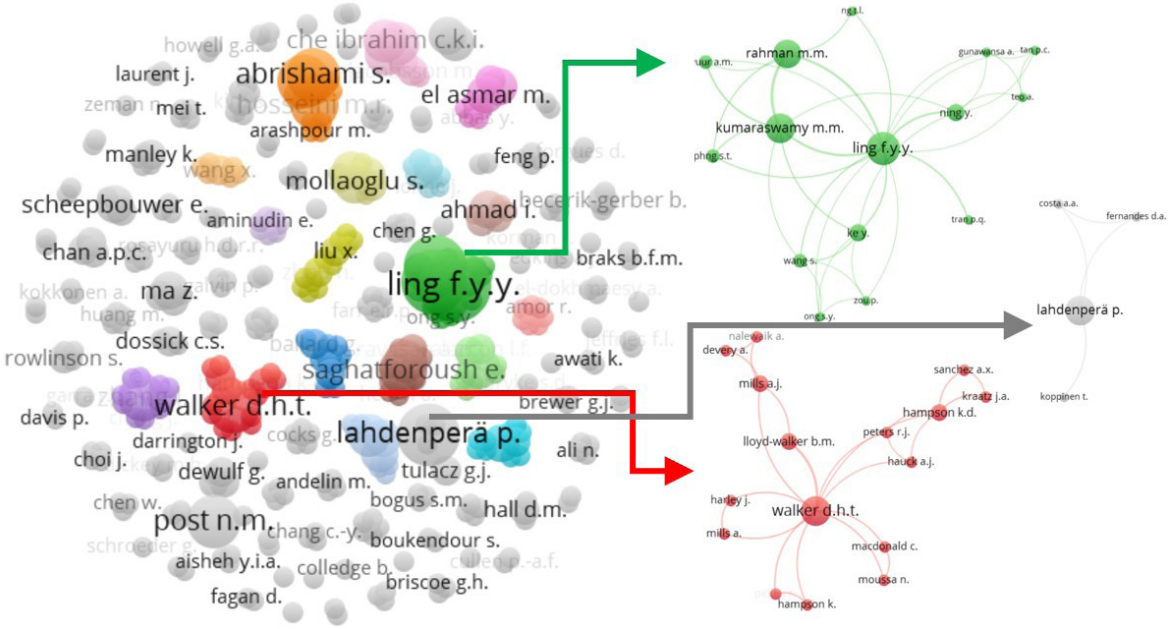

Figure 4. *Co-authorship analysis in VOSviewer.*

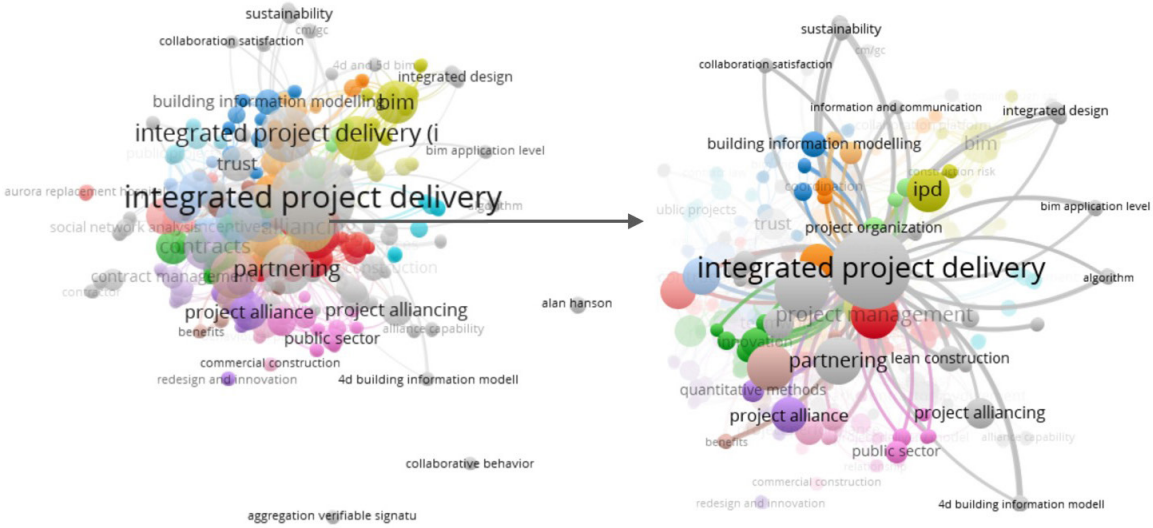

Figure 5. *Co-occurrence analysis in VOSviewer.*

and the records assessed for eligibility were subject to further assessment to ensure their quality. Studies excluded due to quality assessment were not included in this step and discussion on performance outcomes of IPD. The aim of this differentiation was that all relevant documents could be analyzed and classified in bibliometric and scientometric analyzes without any exclusion due to quality measurement, and IPD related issues and performance outcomes could be discussed by including only eligible studies.

5.1. Quality assessment

Quality assessment of publications is a complex and multi-dimensional process, and there are different approaches for quality measurement. The use of journal metrics is more proper because journal metrics are theoretically and statistically well founded and based on accurate and extensive data (Moed, 2005). All citations are considered equal in traditional citation analysis, and a citation from a widely read journal is accepted as strongly as one from a locally popular journal (Moed et al., 2012). There are some alternative metrics for quality assessment such as Scimago Journal Rank (SJR) and Source Normalized Impact per Paper (SNIP). SJR is a reputable metric inspired by Google's PageRank, whereby a journal's quality has a direct effect upon the value of the citations it gives to other journals (Gonza´lez-Pereira, 2009). The approach used in SJR was found acceptable, and quality assessment was performed by using SJR metrics in this study.

There are four quartiles in SJR, Q1, Q2, Q3, and Q4, that classify journals according to their citation numbers and prestige. In this study, Q1 and Q2 quartiles, which include more cited and prestigious journals than other quartiles, were chosen as the standard for the quality assessment of the articles to be included in the last two steps of the study. 61 articles, 51 from Scopus and 10 from WoS, were excluded due to their inability to meet the required benchmark determined, and 146 studies were analyzed in the third step.

5.2. Definitions of IPD

There is no industry-wide agreed-upon definition of IPD, and 27 different definitions of IPD are determined in the literature as shown in Table 1. IPD definitions are still evolving; however, the most widely accepted definition is the first definition in Table 1, which was proposed by the American Institute of Architects (AIA) in 2007. Other project delivery systems such as collaborative Design Build (DB) or relational contracting could also be understood from the first definition. The second definition in Table 1 was presented by AIA in 2010, which more explicitly distinguishes between a traditional and IPD system.

Benefiting from the information obtained from this study and the existing definitions, IPD could be defined comprehensively as "a project delivery system that aims to integrate organizations, teams, systems, skills, technology, information, business interests, and focuses on optimizing project performances, reducing wastes, improving productivity, increasing value to the owner, increasing collaboration through multi-party contract, early involvement of stakeholders, risk and profit sharing, collaborative engagement of stakeholders, collaborative decision making, mutual respect and trust throughout project life cycles."

5.3. Principles / Characteristics of IPD

As a result of immature IPD structure and absence of single set of practices, principles or characteristics of IPD vary from source to source. 54 different IPD principles are identified in the literature as shown in Table 2. IPD principles published by AIA are the most commonly accepted and used principles in the industry. AIA defined nine IPD principles in 2007, and then AIA made alterations and defined six main IPD characteristics in 2010 as shown in Table 2. The following IPD characteristics were considered highly desirable by AIA in 2010: mutual respect and trust, collaborative innovation, intensified early planning, open communication, BIM used by multiple parties, lean

Table 1. *The definitions of IPD in the literature.*

Nu.	Definitions	Used Studies	Freq.
1	IPD is a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively harnesses the talents and insights of all project participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.	(Aapaoja et al., 2013; Choi et al., 2019; Elghaish et al., 2021; Ghassemi & Becerik-Gerber, 2011; Hall & Scott, 2019; Kent & Becerik-Gerber, 2010; Kraatz et al., 2014; Liu et al., 2021; Ma et al., 2017; Mei et al., 2017; Mesa et al., 2019; Othman & Youssef, 2020; Piroozfar et al., 2019; Rosayuru et al., 2019; Roy et al., 2018; Sun et al., 2015; Teng et al., 2019; Trach et al., 2020; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang et al., 2013)	21
2	IPD is a method of project delivery distinguished by a contractual arrangement among a minimum of owner, constructor, and design professional that aligns business interests of all parties.	(Azhar et al., 2015; Hanna, 2016; Ibrahim et al., 2020; Lahdenperä, 2012; Mesa et al., 2019; Sun et al., 2015)	6
3	IPD is a delivery system distinguished by a multiparty agreement and the very early involvement of key participants.	(Durdyev et al., 2020; El Asmar et al., 2016; El Asmar et al., 2013)	3
4	IPD is a business model for designing, executing and delivering the building through collaborative, integrated and productive techniques and project participants.	(Othman & Youssef, 2020)	1
5	IPD is an emerging project delivery approach aims to minimise waste in construction projects which leads to optimal improvement in schedule, cost and quality.	(Othman & Youssef, 2020)	1
6	IPD is a method that improves the project through integrating project team and binding continuous cooperation among project stakeholders.	(Jadidoleslami et al., 2019)	1
7	IPD is a contractual system for project delivery. It integrates project stakeholders throughout project life cycle.	(Kahvandi et al., 2018)	1
8	IPD includes presence of all key factors of the project from outset in an integrated manner, and using their experiences in a multilateral contract to have a successful project and participation in risk and reward for all stakeholders in project life cycle.	(Kahvandi et al., 2018)	1
9	IPD is widely regarded as a modern delivery method of construction projects that can provide the most effective and efficient way of procuring built assets.	(Durdyev et al., 2020)	1
10	IPD is a construction project contractual structure, promotes risk and profit sharing among project participants to resolve systemic problems of traditional contractual approach.	(Sun et al., 2015)	1
11	IPD is an approach that integrates people, systems, business structures and practices through a multi-party agreement to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design and construction.	(Mesa et al., 2019)	1
12	IPD is an approach to project delivery that incorporates people, a framework, business structures and practices into one system.	(Whang et al., 2019)	1
13	IPD is a business model for the integration of the design and construction stakeholders which is not tied to a specific contract type or technologies, but is rather a set of principles that can be applied to a range of circumstances.	(Kraatz et al., 2014)	1
14	IPD is a form of collaborative project delivery model designed to share the project resource pool, project decision-making rights, and the project outcome among multiple firms.	(Hall & Bonanomi, 2021)	1
15	IPD is an emerging delivery system in which members' success depends on collaboration and teamwork amongst main parties.	(Chang et al., 2017)	1
16	IPD is a relational construction delivery method in which the owner, designer and contractors are contractually bound to one another to perform/deliver projects as one team comprised of members that have agreed to put the interests of the "project as a whole" before their own interests.	(Singleton & Hamzeh, 2011)	1
17	IPD is a project delivery method that brings all stakeholders together for a common purpose and connects them with a contract.	(Bilge & Yaman, 2021)	1
18	IPD is a Relational Contracting approach that aligns project objectives with the interests of key participants. It creates an organization able to apply the principles and practices of the Lean Project Delivery System.	(Matthews & Howell, 2005)	1
19	IPD is an innovative project delivery method characterised by early, collaborative and collective engagement of key stakeholders across all phases of delivering a project.	(Elghaish et al., 2019)	1
20	IPD is a project delivery system using a multi party contract that has more than two parties selected by qualification based procurement, managed/shared risk, compensation based on team performance without GMP, and open book accounting.	(Cho & Ballard, 2011)	1
21	IPD may set all who believe there is a better way to deliver projects on a path to transform the status quo of fragmented processes yielding outcomes below expectations to a collaborative, value-based process delivering high-outcome results to the entire building team.	(Uihlein, 2016)	1
22	IPD is a new delivery mode that attempts to solve some problems in construction sector using a collaborative process to integrate people, systems, business structures, and practices to harness the knowledge and expertise of all participants involved in a project.	(Zhang et al., 2016)	1
23	IPD is an alternative design and construction contracting method for capital projects.	(Kelly & Ilozor, 2022)	1
24	IPD is a multiparty contract that includes contractual and behavioral elements.	(Laurent & Leicht, 2019)	1
25	IPD is a trust-based delivery method that achieves collaboration, with the stipulation that many aspects are related to the of engagement of the owner.	(Laurent & Leicht, 2019)	1
26	IPD is a project delivery method that aims to optimize project performance by eliminating adversarial relationships and improving collaboration among project participants.	(Abdirad & Dossick, 2019)	1
27	IPD is a highly collaborative process that integrates the expertise of project teams during the early project stages.	(Ghassemi & Becerik-Gerber, 2011)	1

principles of design, construction and operations, co-location of teams, transparent financials.

In consequence of this comprehensive literature review, it could be asserted that green items in Table 2 (Nu. 1-10), which were the most frequently mentioned IPD principles by the researchers, should be the main principles of IPD. Yellow items in Table 2 (Nu. 11, 12, 14, 17, 18, and 19), which were mentioned by AIA and many researchers, could be optional and accelerator principles for IPD implementation in the AEC sector.

5.4. Benefits / Advantages of IPD

Numerous research efforts have highlighted the benefits or positive aspects of utilizing IPD. In this study, the benefits of IPD were reviewed elaborately, compiled, and put in order by frequency of occurrence. 44 different benefits of IPD are determined in the literature as shown in Table 3.

Table 2. *The principles/characteristics of IPD in the literature.*

Nu.	Principles / Characteristics	Mentioned Studies	Freq.	AIA 2007	AIA 2010
1	Risk/pain and reward/gain sharing	(Aapaoja et al., 2013; Abdirad & Dossick, 2019; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Ballard et al., 2015; Bilge & Yaman, 2021; Chang et al., 2017; Chen et al., 2020; Cho & Ballard, 2011; Choi et al., 2019; Darrington, 2011; Durdyev et al., 2020; El Asmar et al., 2013; Elghaish, Abrishami, & Hosseini, 2020; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2021; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Elghaish et al., 2019; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Johnson et al., 2013; Kahvandi et al., 2018; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Kokkonen & Vaagaasar, 2018; Kraatz et al., 2014; Lahdenperä, 2012; Laurent & Leicht, 2019; Ma & Ma, 2017; Ma et al., 2017; Manata et al., 2018; Manata et al., 2021; Marinho et al., 2021; Matthews & Howell, 2005; Mei et al., 2017; Mesa et al., 2019; Mesa et al., 2016; Nifa. F. A. A. et al., 2015; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Roy et al., 2018; Salcedo Rahola & Straub, 2016; Singleton & Hamzeh, 2011; Teng et al., 2019; Trach et al., 2020; Uihlein, 2016; Yu et al., 2019; Zhang, Cao, & Wang, 2018; Zhang et al., 2020; Zhang et al., 2016)	57	✓	✓
2	Early involvement/engagement of stakeholders	(Abdirad & Dossick, 2019; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Bilge & Yaman, 2021; Chang et al., 2017; Cho & Ballard, 2011; Choi et al., 2019; Darrington, 2011; Durdyev et al., 2020; El Asmar et al., 2016; El Asmar et al., 2013; Elghaish, Abrishami, & Hosseini, 2020; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2021; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Kahvandi et al., 2018; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Kim & Dossick, 2011; Kokkonen & Vaagaasar, 2018; Kraatz et al., 2014; Lahdenperä, 2012; Laurent & Leicht, 2019; Liu et al., 2021; Ma & Ma, 2017; Ma et al., 2018; Ma et al., 2017; Manata et al., 2018; Manata et al., 2021; Marinho et al., 2021; Mei et al., 2017; Mesa et al., 2019; Nifa. F. A. A. et al., 2015; Nwajei, 2021; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Roy et al., 2018; Teng et al., 2019; Trach et al., 2020; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang, Cao, & Wang, 2018; Zhang et al., 2020; Zhang et al., 2016)	55	✓	✓
3	Multi-party contract	(Aapaoja et al., 2013; Abdirad & Dossick, 2019; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Ballard et al., 2015; Chang et al., 2017; Cho & Ballard, 2011; Choi et al., 2019; Darrington, 2011; El Asmar et al., 2016; El Asmar et al., 2013; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Engebø et al., 2020; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Johnson et al., 2013; Kahvandi et al., 2018; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Kim & Dossick, 2011; Kokkonen & Vaagaasar, 2018; Lahdenperä, 2012; Laurent & Leicht, 2019; Liu et al., 2021; Ma & Ma, 2017; Marinho et al., 2021; Matthews & Howell, 2005; Mei et al., 2017; Mesa et al., 2019; Mesa et al., 2016; Nwajei, 2021; Paik et al., 2017; Piroozfar et al., 2019; Roy et al., 2018; Salcedo Rahola & Straub, 2016; Sun et al., 2015; Teng et al., 2019; Trach et al., 2020; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang, Cao, & Wang, 2018; Zhang et al., 2020; Zhang et al., 2016)	48		✓
4	Collaborative/collective engagement of stakeholders	(Abdirad & Dossick, 2019; Ahmad et al., 2019; Azhar et al., 2015; Bilge & Yaman, 2021; Chang et al., 2017; Chen et al., 2020; Choi et al., 2019; Darrington, 2011; Durdyev et al., 2020; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2021; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Kahvandi et al., 2018; Kelly & Ilozor, 2022; Kim & Dossick, 2011; Kraatz et al., 2014; Lahdenperä, 2012; Laurent & Leicht, 2019; Liu et al., 2021; Ma & Ma, 2017; Ma et al., 2018; Manata et al., 2021; Marinho et al., 2021; Mei et al., 2017; Mesa et al., 2019; Mesa et al., 2016; Nifa. F. A. A. et al., 2015; Nwajei, 2021; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Sun et al., 2015; Teng et al., 2019; Trach et al., 2020; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang, Cao, & Wang, 2018; Zhang et al., 2020; Zhang et al., 2016)	47		
5	Collaborative decision making and control (each participant's contribution)	(Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Cho & Ballard, 2011; Choi et al., 2019; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Johnson et al., 2013; Kahvandi et al., 2018; Kokkonen & Vaagaasar, 2018; Kraatz et al., 2014; Lahdenperä, 2012; Laurent & Leicht, 2019; Ma & Ma, 2017; Ma et al., 2018; Ma et al., 2017; Manata et al., 2021; Marinho et al., 2021; Mei et al., 2017; Mesa et al., 2019; Mesa et al., 2016; Nifa. F. A. A. et al., 2015; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Singleton & Hamzeh, 2011; Trach et al., 2020; Uihlein, 2016; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang et al., 2020)	38	✓	✓
6	Mutual respect and trust	(Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Durdyev et al., 2020; Elghaish, Abrishami, & Hosseini, 2020; Ghassemi & Becerik-Gerber, 2011; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Kahvandi et al., 2018; Lahdenperä, 2012; Liu et al., 2021; Ma & Ma, 2017; Ma et al., 2017; Manata et al., 2021; Marinho et al., 2021; Mei et al., 2017; Mesa et al., 2019; Nifa. F. A. A. et al., 2015; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Singleton & Hamzeh, 2011; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang et al., 2020; Zhang et al., 2016)	31	✓	
7	Appropriate technology (BIM, VDC, blockchain, etc.)	(Aapaoja et al., 2013; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Bilge & Yaman, 2021; Chang et al., 2017; Elghaish, Abrishami, & Hosseini, 2020; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2020; Elghaish et al., 2019; Hall & Scott, 2019; Kelly & Ilozor, 2022; Kim & Dossick, 2011; Lahdenperä, 2012; Liu et al., 2021; Ma & Ma, 2017; Ma et al., 2017; Marinho et al., 2021; Mei et al., 2017; Mesa et al., 2019; Nifa. F. A. A. et al., 2015; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Whang et al., 2019; Yu et al., 2019; Zhang et al., 2020)	28	✓	
8	Open/effective communications	(Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Ghassemi & Becerik-Gerber, 2011; Hanna, 2016; Jadidoleslami et al., 2019; Kahvandi et al., 2018; Kraatz et al., 2014; Lahdenperä, 2012; Ma & Ma, 2017; Ma et al., 2017; Marinho et al., 2021; Mesa et al., 2019; Nifa. F. A. A. et al., 2015; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang, Cao, & Wang, 2018; Zhang et al., 2020; Zhang et al., 2016)	25	✓	
9	Jointly developed and validated project goals	(Abdirad & Dossick, 2019; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Cho & Ballard, 2011; El Asmar et al., 2013; Ghassemi & Becerik-Gerber, 2011; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Kahvandi et al., 2018; Lahdenperä, 2012; Ma & Ma, 2017; Manata et al., 2021; Mei et al., 2017; Mesa et al., 2019; Othman & Youssef, 2020; Singleton & Hamzeh, 2011; Trach et al., 2020; Uihlein, 2016; Yu et al., 2019; Zhang et al., 2020)	23		✓
10	Liability waivers among participants (ignoring claims/accepting risks at the beginning)	(Abdirad & Dossick, 2019; Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Cho & Ballard, 2011; El Asmar et al., 2013; Ghassemi & Becerik-Gerber, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Johnson et al., 2013; Kahvandi et al., 2018; Lahdenperä, 2012; Ma & Ma, 2017; Mesa et al., 2019; Yu et al., 2019; Zhang et al., 2020)	19		✓
11	Open pricing techniques and fiscal transparency amongst participants	(Ahmad et al., 2019; Andary et al., 2020; Chang et al., 2017; El Asmar et al., 2013; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2021; Hall & Bonanomi, 2021; Hall & Scott, 2019; Hanna, 2016; Jadidoleslami et al., 2019; Kokkonen & Vaagaasar, 2018; Kraatz et al., 2014; Lahdenperä, 2012; Laurent & Leicht, 2019; Ma & Ma, 2017; Mesa et al., 2019; Paik et al., 2017; Yu et al., 2019)	18		
12	Early and careful planning	(Andary et al., 2020; Azhar et al., 2015; Chang et al., 2017; Hall & Scott, 2019; Hanna, 2016; Kahvandi et al., 2018; Lahdenperä, 2012; Ma & Ma, 2017; Ma et al., 2017; Marinho et al., 2021; Mesa et al., 2019; Piroozfar et al., 2019; Rosayuru et al., 2019; Yu et al., 2019)	14	✓	
13	Target value design	(Ballard et al., 2015; Darrington, 2011; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish & Abrishami, 2021; Elghaish & Abrishami, 2020; Hall & Bonanomi, 2021; Johnson et al., 2013; Laurent & Leicht, 2019; Ma & Ma, 2017; Ma et al., 2018; Mesa et al., 2019; Mesa et al., 2016; Singleton & Hamzeh, 2011; Sun et al., 2015)	14		
14	Lean construction principles	(Aapaoja et al., 2013; Ahmad et al., 2019; Andary et al., 2020; Chang et al., 2017; Darrington, 2011; Hall & Bonanomi, 2021; Hall & Scott, 2019; Kim & Dossick, 2011; Lahdenperä, 2012; Laurent & Leicht, 2019; Ma & Ma, 2017; Mesa et al., 2019; Rosayuru et al., 2019; Singleton & Hamzeh, 2011)	14		
15	Sharing information	(Chang et al., 2017; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Elghaish et al., 2019; Hall & Scott, 2019; Kahvandi et al., 2018; Ma & Ma, 2017; Mesa et al., 2019; Paik et al., 2017; Piroozfar et al., 2019; Uihlein, 2016; Whang et al., 2019; Yu et al., 2019; Zhang et al., 2020)	13		
16	The aim of optimizing the entire project as opposed to seeking the self-interest of their respective organizations (common interests)	(Elghaish, Abrishami, & Hosseini, 2020; Jadidoleslami et al., 2019; Kim & Dossick, 2011; Ma et al., 2018; Marinho et al., 2021; Paik et al., 2017; Piroozfar et al., 2019; Roy et al., 2018; Teng et al., 2019; Zhang et al., 2020; Zhang et al., 2016)	11		
17	Organization and leadership	(Andary et al., 2020; Azhar et al., 2015; Darrington, 2011; Kim & Dossick, 2011; Ma & Ma, 2017; Ma et al., 2017; Marinho et al., 2021; Nifa. F. A. A. et al., 2015; Piroozfar et al., 2019; Rosayuru et al., 2019; Yu et al., 2019)	11	✓	
18	Co-location of teams	(Andary et al., 2020; Chang et al., 2017; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Hall & Scott, 2019; Kokkonen & Vaagaasar, 2018; Lahdenperä, 2012; Ma & Ma, 2017; Mesa et al., 2019; Zhang et al., 2020)	9		
19	Early goal definition	(Andary et al., 2020; Azhar et al., 2015; Ma et al., 2017; Marinho et al., 2021; Nifa. F. A. A. et al., 2015; Piroozfar et al., 2019; Yu et al., 2019)	7	✓	
20	Intensified design	(Ahmad et al., 2019; Hanna, 2016; Lahdenperä, 2012; Mesa et al., 2019; Paik et al., 2017; Piroozfar et al., 2019; Yu et al., 2019)	7		
21	Relational contracts	(Andary et al., 2020; Kim & Dossick, 2011; Ma & Ma, 2017; Manata et al., 2021; Matthews & Howell, 2005; Roy et al., 2018; Zhang et al., 2020)	7		
22	Integrated group building, integrated team	(Aapaoja et al., 2013; Andary et al., 2020; Chang et al., 2017; Choi et al., 2019; Kelly & Ilozor, 2022; Singleton & Hamzeh, 2011)	6		
23	Clearly defined team responsibilities	(Hall & Bonanomi, 2021; Kahvandi et al., 2018; Othman & Youssef, 2020; Yu et al., 2019)	4		
24	Key participants bound together as equals	(Ahmad et al., 2019; Andary et al., 2020; Hanna, 2016; Lahdenperä, 2012)	4		
25	Joint project control	(Abdirad & Dossick, 2019; Elghaish et al., 2019; Hall & Scott, 2019; Singleton & Hamzeh, 2011)	4		
26	Encouragement for innovative ideas	(Lahdenperä, 2012; Mesa et al., 2019; Othman & Youssef, 2020; Paik et al., 2017)	4		
27	Alignment of goals with the client's desired outcomes	(Piroozfar et al., 2019; Singleton & Hamzeh, 2011; Yu et al., 2019)	3		
28	Dispute resolution procedures in the contract	(Hall & Bonanomi, 2021; Johnson et al., 2013; Rosayuru et al., 2019)	3		
29	Continuous improvement	(Johnson et al., 2013; Rosayuru et al., 2019; Singleton & Hamzeh, 2011)	3		
30	Award fees, performance evaluation	(Andary et al., 2020; Rosayuru et al., 2019; Singleton & Hamzeh, 2011)	3		
31	Early identification of risk	(Laurent & Leicht, 2019; Ma & Ma, 2017; Rosayuru et al., 2019)	3		
32	Allocation of parties' profits at the end of project	(Elghaish, Abrishami, & Hosseini, 2020; Elghaish & Abrishami, 2021)	2		
33	Legal relationships (consistent with public law requirements)	(Ma & Ma, 2017; Rosayuru et al., 2019)	2		
34	Equal commitment of main participants	(Jadidoleslami et al., 2019; Mesa et al., 2019)	2		
35	Data collection	(Kahvandi et al., 2018; Piroozfar et al., 2019)	2		
36	Transparent and intensified relations	(Kahvandi et al., 2018; Ma & Ma, 2017)	2		
37	Full-time and high performing staffing	(Chang et al., 2017; Singleton & Hamzeh, 2011)	2		
38	Integrated project insurance	(Chang et al., 2017; Rosayuru et al., 2019)	2		
39	No-blame culture	(Othman & Youssef, 2020)	1		
40	Common creativities	(Kahvandi et al., 2018)	1		
41	Communication contract	(Kahvandi et al., 2018)	1		
42	Collaborative review of the contract	(Yu et al., 2019)	1		
43	Quick decisions by the client	(Yu et al., 2019)	1		
44	Metric-based decisions	(Ma & Ma, 2017)	1		
45	Nested management levels	(Hall & Bonanomi, 2021)	1		
46	Replacing the tender stage by the buyout stage	(Elghaish, Abrishami, & Hosseini, 2020)	1		
47	Qualification-based selection	(Laurent & Leicht, 2019)	1		
48	Pioneering role of the client/owner	(Rosayuru et al., 2019)	1		
49	Whole life value assessment	(Rosayuru et al., 2019)	1		
50	Separate project bank account for each project	(Rosayuru et al., 2019)	1		
51	Safety plan and project labour agreement	(Rosayuru et al., 2019)	1		
52	Clarity of management decisions	(Rosayuru et al., 2019)	1		
53	Positive attitude of the project participants	(Rosayuru et al., 2019)	1		
54	Professional ethics	(Rosayuru et al., 2019)	1		

Legend	
✓	Main IPD charact. defined by AIA
	Considered as highly desirable IPD charact. by AIA
	Main IPD charact. proposed in this study
	Optional and accelerator IPD charact. proposed in this study

Table 3. *The benefits/advantages of IPD in the literature.*

Nu.	Benefits / Advantages	Mentioned Studies	Freq.
1	Shorter schedules	(Ahmad et al., 2019; Andary et al., 2020; Durdyev et al., 2020; El Asmar et al., 2016; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Johnson et al., 2013; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Ma et al., 2018; Ma et al., 2017; Mesa et al., 2016; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Schroeder, 2014; Singleton & Hamzeh, 2011; Yu et al., 2019; Zhang et al., 2020)	20
2	Increased cost savings	(Ahmad et al., 2019; Andary et al., 2020; Durdyev et al., 2020; El Asmar et al., 2013; Ghassemi & Becerik-Gerber, 2011; Kahvandi et al., 2018; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Ma et al., 2018; Matthews & Howell, 2005; Mesa et al., 2016; Othman & Youssef, 2020; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Singleton & Hamzeh, 2011; Teng et al., 2019; Yu et al., 2019; Zhang, Huang, & Peng, 2018; Zhang et al., 2020)	20
3	Increased efficiency / Improved productivity	(Andary et al., 2020; Durdyev et al., 2020; Elghaish et al., 2019; Hall & Bonanomi, 2021; Hanna, 2016; Kent & Becerik-Gerber, 2010; Mei et al., 2017; Othman & Youssef, 2020; Piroozfar et al., 2019; Rosayuru et al., 2019; Rowlinson, 2017; Schroeder, 2014; Sun et al., 2015; Uihlein, 2016; Zhang et al., 2020)	15
4	Increased cooperation/collaboration, better relationships	(Andary et al., 2020; Choi et al., 2019; Durdyev et al., 2020; Hall & Bonanomi, 2021; Harper et al., 2016; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Matthews & Howell, 2005; Nifa. F. A. A. et al., 2015; Paik et al., 2017; Piroozfar et al., 2019; Rosayuru et al., 2019; Schroeder, 2014; Sun et al., 2015; Uihlein, 2016)	15
5	Enhancing the quality of communications and trust	(Ahmad et al., 2019; Azhar et al., 2015; Bilge & Yaman, 2021; Durdyev et al., 2020; El Asmar et al., 2016; Manata et al., 2018; Marinho et al., 2021; Matthews & Howell, 2005; Mesa et al., 2016; Piroozfar et al., 2019; Sun et al., 2015; Yu et al., 2019; Zhang et al., 2020)	13
6	Reducing wastes	(Andary et al., 2020; Durdyev et al., 2020; Elghaish & Abrishami, 2020; Elghaish et al., 2021; Hall & Bonanomi, 2021; Hanna, 2016; Kent & Becerik-Gerber, 2010; Laurent & Leicht, 2019; Liu et al., 2021; Marinho et al., 2021; Piroozfar et al., 2019; Rosayuru et al., 2019; Zhang et al., 2020)	13
7	Better quality	(Ahmad et al., 2019; Andary et al., 2020; Azhar et al., 2015; El Asmar et al., 2016; Kelly & Ilozor, 2022; Kent & Becerik-Gerber, 2010; Ma et al., 2017; Mesa et al., 2016; Othman & Youssef, 2020; Paik et al., 2017; Rosayuru et al., 2019; Singleton & Hamzeh, 2011)	12
8	Reduced errors and duplications	(Andary et al., 2020; El Asmar et al., 2013; Elghaish et al., 2019; Jadidoleslami et al., 2019; Kent & Becerik-Gerber, 2010; Mei et al., 2017; Rosayuru et al., 2019; Yu et al., 2019; Zhang et al., 2020)	9
9	Increased value to the owner	(Andary et al., 2020; El Asmar et al., 2013; Elghaish et al., 2021; Hanna, 2016; Kelly & Ilozor, 2022; Laurent & Leicht, 2019; Liu et al., 2021; Marinho et al., 2021)	8
10	Assisting in const. greener build. (higher environ. sustainability)	(Azhar et al., 2015; Durdyev et al., 2020; Johnson et al., 2013; Mei et al., 2017; Nifa. F. A. A. et al., 2015; Rosayuru et al., 2019; Sun et al., 2015; Teng et al., 2019)	8
11	Fewer change orders	(Ahmad et al., 2019; Andary et al., 2020; Kent & Becerik-Gerber, 2010; Ma et al., 2018; Ma et al., 2017; Othman & Youssef, 2020; Yu et al., 2019)	7
12	Reduced conflicts/disputes	(Andary et al., 2020; Azhar et al., 2015; Jadidoleslami et al., 2019; Mesa et al., 2016; Rosayuru et al., 2019; Sun et al., 2015)	6
13	Client satisfaction	(Ahmad et al., 2019; Durdyev et al., 2020; Hall & Scott, 2019; Mesa et al., 2016; Rosayuru et al., 2019; Yu et al., 2019)	6
14	Increased reward/profit	(Ahmad et al., 2019; Azhar et al., 2015; Johnson et al., 2013; Mesa et al., 2016; Rosayuru et al., 2019; Zhang, Huang, & Peng, 2018)	6
15	Having potential for eliminating the barriers of BIM implem.	(Chang et al., 2017; Elghaish et al., 2019; Kent & Becerik-Gerber, 2010; Marinho et al., 2021; Piroozfar et al., 2019; Zhang et al., 2020)	6
16	Having potential for integration with innovative applications	(Durdyev et al., 2020; Kraatz et al., 2014; Laurent & Leicht, 2019; Piroozfar et al., 2019; Rosayuru et al., 2019)	5
17	Fewer requests for information (RFIs)	(Andary et al., 2020; Hanna, 2016; Kent & Becerik-Gerber, 2010; Ma et al., 2018)	4
18	Management of change	(Kent & Becerik-Gerber, 2010; Rosayuru et al., 2019; Yu et al., 2019; Zhang et al., 2020)	4
19	Better planning	(Elghaish & Abrishami, 2020; Elghaish et al., 2021; Kent & Becerik-Gerber, 2010)	3
20	Fewer injuries (improvement in safety)	(Ahmad et al., 2019; Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020)	3
21	Improved constructability	(El Asmar et al., 2013; Jadidoleslami et al., 2019; Rosayuru et al., 2019)	3
22	Better design quality	(Johnson et al., 2013; Rosayuru et al., 2019; Uihlein, 2016)	3
23	Improved working environment	(Laurent & Leicht, 2019; Nifa. F. A. A. et al., 2015; Rosayuru et al., 2019)	3
24	Reduced operations and maintenance costs	(Kent & Becerik-Gerber, 2010; Piroozfar et al., 2019)	2
25	Reduced design effort	(Andary et al., 2020; Othman & Youssef, 2020)	2
26	Better energy risk management	(Durdyev et al., 2020; Kahvandi et al., 2018)	2
27	Increased potential for return business	(El Asmar et al., 2016; Hanna, 2016)	2
28	Less construction administration	(Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020)	2
29	Enhanced cost and schedule predictability	(Ahmad et al., 2019; Azhar et al., 2015)	2
30	More prefabricated materials	(Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020)	2
31	Increased control and supervision of project managers	(Kahvandi et al., 2018)	1
32	Shorter change order processing time	(Hanna, 2016)	1
33	Positive impact on company image	(Hanna, 2016)	1
34	Collective backup capabilities	(Whang et al., 2019)	1
35	Problem-area identification	(Whang et al., 2019)	1
36	Reduced owner's supervision cost of rent-seeking activities	(Mei et al., 2017)	1
37	Improved owner's supervision efficiency of rent-seeking activit.	(Mei et al., 2017)	1
38	Standardization in industry	(Rosayuru et al., 2019)	1
39	Increase in accuracy and speed of information	(Rosayuru et al., 2019)	1
40	Resource optimization	(Rosayuru et al., 2019)	1
41	Enhancing improvements in society, increasing living standards	(Rosayuru et al., 2019)	1
42	Less risky project overall	(Ghassemi & Becerik-Gerber, 2011)	1
43	Less stress and friction	(Kent & Becerik-Gerber, 2010)	1
44	More enjoyable projects	(Kent & Becerik-Gerber, 2010)	1

5.5. Barriers / Constraints to IPD implementation

The AEC sector faces significant barriers in IPD implementation, and there are some inhibitors to widespread IPD use. The most common barriers must be eliminated to facilitate a faster transition to IPD. Some studies have investigated barriers to IPD implementation, and this study will contribute to the literature by compiling barriers or constraints, putting barriers in order by frequency of occurrence, and highlighting the critical issues.

Identified barriers were classified into 6 groups which are contractual/ legal, behavioral/cultural, administrative/managerial/procedural, organizational/qualitative, financial, and technological. Barriers mentioned more than twice in the literature are shown with colored lines in Table 4 to highlight the most common issues in the AEC sector.

5.6. Research methods used in studies related to IPD

Research methods used in 146 studies related to IPD were also analyzed, and 14 different research methods were identified. The total number of methods is evaluated as 257 because more than one method is used in some studies. The most commonly used research method in the selected IPD researches was case study/case study review with a rate of 25.29%, and it was followed by literature review with a rate of 19.84%. The remaining methods were survey/ Delphi questionnaires (17.51%), interviews (15.95%), a framework/a model (14.79%), regression analysis (1.56%), partial least squares structural equation modelling (1.56%), fuzzy set theory (0.78%), simulation (0.78%), fuzzy cognitive mapping technique (0.39%), evolutionary game model (0.39%), conceptualization (0.39%), cooperative game theory (0.39%), and system dynamics approach (0.39%).

6. Discussion on performance outcomes of IPD

Bibliometric data can offer the insights required to assess the performance of a particular field within the literature. Moreover, the findings from bibliometric analysis can identify the key factors that enhance contributions within a particular area of research and guide scholars toward carrying out more impactful studies. In the process of conducting this systematic review, particular attention was paid to performance outcomes of the projects that used IPD or IPD principles as well as performance comparisons of IPD with traditional PDSs.

In addition to 146 eligible studies determined by applying the explained criteria and quality assessment, IPD case studies published by AIA California Council in 2010 and by the University of Minnesota in 2012 are also included in the review of performance outcomes. The findings of this current research show that there are limited studies examining performance outcomes of IPD, and only 33 performance evaluations for IPD are identified among these studies. It is observed that most of the case studies are related to other issues such as collaboration, relationships, relational contracting, alliancing, legal issues.

It should be noted that performance evaluations may differ depending on variables such as performance metrics, evaluator party, and data quality. In this study, identified 33 performance evaluations among 148 studies were examined in terms of 7 performance areas which are cost, time, quality, communication, change management, business, and HSE. By reviewing the identified studies, findings in 7 performance areas are compiled and demonstrated in Table 5. Researchers have mostly studied cost (25 of 33 evaluations) and time (26 of 33 evaluations) performances.

As it is demonstrated in Table 5, most of the performance evaluations are based on a single sample, and the rate of IPD cases is low in sample sizes. Almost all of the studies are performed in United States, and the oldest performance evaluation for IPD is in 2003. Further, IPD has largely been implemented in healthcare projects, and there are limited outcomes in other types of projects such as office, education facility, and industrial.

Table 4. *The barriers/constraints to IPD implementation.*

Nu.	Contractual / Legal	Mentioned Studies	Freq.	Behavioral / Cultural	Mentioned Studies	Freq.	Administrative / Managerial / Procedural	Mentioned Studies	Freq.	Organizational / Qualitative	Mentioned Studies	Freq.	Financial	Mentioned Studies	Freq.	Technological	Mentioned Studies	Freq.
1	Lack of governmental incentives, policies or regulations	(Ahmad et al., 2019; Chang et al., 2017; Chen et al., 2020; Darrington, 2011; Durdyev et al., 2020; Ghassemi & Becerik-Gerber, 2011; Hall & Scott, 2019; Johnson et al., 2013; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020; Rosayuru et al., 2019; Roy et al., 2018; Teng et al., 2019)	14	Reluctance to use new contractual methods and tend to use conventional ones (resistance to change)	(Aapaoja et al., 2013; Durdyev et al., 2020; Ghassemi & Becerik-Gerber, 2011; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Kim & Dossick, 2011; Matthews & Howell, 2005; Othman & Youssef, 2020; Paik et al., 2017; Rosayuru et al., 2019; Roy et al., 2018; Sun et al., 2015; Uihlein, 2016)	13	Poor data transfer among different phases of a project (resistance to information sharing)	(Durdyev et al., 2020; Elghaish et al., 2019; Kahvandi et al., 2018; Rosayuru et al., 2019; Teng et al., 2019)	5	Lack of IPD experience amongst stakeholders	(Aapaoja et al., 2013; Ahmad et al., 2019; Azhar et al., 2015; Chang et al., 2017; Durdyev et al., 2020; Hall & Scott, 2019; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Laurent & Leicht, 2019; Matthews & Howell, 2005; Othman & Youssef, 2020; Roy et al., 2018)	12	Unclear IPD compensation structure	(Elghaish & Abrishami, 2021; Elghaish et al., 2019; Ghassemi & Becerik-Gerber, 2011; Matthews & Howell, 2005; Othman & Youssef, 2020; Roy et al., 2018; Teng et al., 2019)	7	Immature BIM platform	(Durdyev et al., 2020; Kent & Becerik-Gerber, 2010; Teng et al., 2019)	3
2	Lack of existence of conditions to assign insurance to whole of the project	(Darrington, 2011; Ghassemi & Becerik-Gerber, 2011; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Matthews & Howell, 2005; Nwajei, 2021; Roy et al., 2018)	7	Poor communication and spirit of collaboration between project stakeholders	(Durdyev et al., 2020; Kahvandi et al., 2018; Othman & Youssef, 2020; Rosayuru et al., 2019; Roy et al., 2018; Sun et al., 2015; Teng et al., 2019)	7	Lack of commitment by clients to an integrated approach	(Durdyev et al., 2020; Kahvandi et al., 2018; Othman & Youssef, 2020; Sun et al., 2015)	4	Lack of clients' awareness and knowledge about IPD and alternative options for higher performance	(Azhar et al., 2015; Durdyev et al., 2020; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020; Roy et al., 2018)	6	Unclear risk/reward sharing structure amongst IPD members	(Durdyev et al., 2020; Elghaish & Abrishami, 2021; Matthews & Howell, 2005; Nwajei, 2021; Roy et al., 2018; Teng et al., 2019)	6	Inexperience with appropriate technology	(Ghassemi & Becerik-Gerber, 2011; Rosayuru et al., 2019; Roy et al., 2018)	3
3	Lack of existence of similar IPD contracts	(Kahvandi et al., 2018; Othman & Youssef, 2020; Roy et al., 2018; Teng et al., 2019)	4	Lack of mutual trust between stakeholders	(Durdyev et al., 2020; Kahvandi et al., 2018; Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020; Rosayuru et al., 2019; Roy et al., 2018)	6	Suitable for big-scaled and complex projects (project sizes and complexity)	(Durdyev et al., 2020; Mesa et al., 2016; Roy et al., 2018)	3	Lack of training and motivation in investing for using IPD	(Durdyev et al., 2020; Kahvandi et al., 2018; Othman & Youssef, 2020; Roy et al., 2018)	4	Unwillingness of the client to share arch. and consult. team in the profits of the project	(Kent & Becerik-Gerber, 2010; Nwajei, 2021; Othman & Youssef, 2020)	3	Non-availability of technological tools/softwares	(Ghassemi & Becerik-Gerber, 2011; Kent & Becerik-Gerber, 2010; Rosayuru et al., 2019)	3
4	Lack of proper definition of responsibilities of each party to the contract	(Abdirad & Dossick, 2019; Kahvandi et al., 2018; Roy et al., 2018; Sun et al., 2015)	4	Unwillingness to cross-disciplinary input during the design phase	(Durdyev et al., 2020; Othman & Youssef, 2020)	2	Disinclination of stakeholders to take risk	(Kent & Becerik-Gerber, 2010; Othman & Youssef, 2020; Roy et al., 2018)	3	Lack of cooperative decision-making skills	(Durdyev et al., 2020; Elghaish et al., 2019; Othman & Youssef, 2020; Teng et al., 2019)	4	Ineffective profit distribution mechanisms	(Durdyev et al., 2020; Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Roy et al., 2018)	3	Ownership and cost of BIM	(Ghassemi & Becer	2
5	Disagreement on liability waivers among stakeholders	(Durdyev et al., 2020; Elghaish et al., 2019; Ghassemi & Becerik-Gerber, 2011; Teng et al., 2019)	4	Unwill. of contractor's to coop. during the design proc. (contractor's late engag. in design)	(Durdyev et al., 2020; Othman & Youssef, 2020)	2	Selection of contractor for lowest-cost bids	(Durdyev et al., 2020; Ghassemi & Becerik-Gerber, 2011; Roy et al., 2018)	3	Lack of knowledge, skills, and experi. about using BIM as an approp. tool for IPD implementation	(Durdyev et al., 2020; Kahvandi et al., 2018; Othman & Youssef, 2020; Rosayuru et al., 2019)	4	Allocation of parties' profits at the end of project	(Elghaish & Abrishami, 2021; Roy et al., 2018)	2	Lack of online collaborative work platforms responding requirements of IPD	(Ma et al., 2018)	1
6	Institutionally immature IPD structure	(Abdirad & Dossick, 2019; Darrington, 2011; Hall & Scott, 2019; Kent & Becerik-Gerber, 2010)	4	Lack of open discuss. about goals and trust the inform. provided by prospective teammates	(Othman & Youssef, 2020; Roy et al., 2018)	2	Uncommitted stakeholders	(Aapaoja et al., 2013; Manata et al., 2021; Matthews & Howell, 2005)	3	Lack of tradespeople or operators involvement	(Durdyev et al., 2020; Othman & Youssef, 2020)	2	Lack of the existing budgeting syst. in considering the differen. betw. proj. deliv. approaches	(Elghaish & Abrishami, 2021; Roy et al., 2018)	2	Lack of integrated synergy due to lack of necessary technology	(Othman & Yousse	1
7	Public institutions and agencies lack authority to restructure their procurement processes	(Darrington, 2011; Ghassemi & Becerik-Gerber, 2011; Kent & Becerik-Gerber, 2010; Roy et al., 2018)	4	Lack of integration of key stakeholders	(Kahvandi et al., 2018; Roy et al., 2018)	2	Slow decision-making process due to the involvement of many participants	(Othman & Youssef, 2020; Roy et al., 2018)	2	Lack of expert consultants in IPD	(Durdyev et al., 2020; Uihlein, 2016)	2	Need for methodology framework to develop a cash flow system within buyout stage	(Elghaish & Abrishami, 2021; Elghaish et al., 2021)	2	Technical problems of BIM/IPD integration	(Durdyev et al., 20	1
8	Un-established/unclear BIM standards and practices (Lack of workable methodology to demonstrate the interrelationship among BIM and IPD stages)	(Elghaish & Abrishami, 2021; Kent & Becerik-Gerber, 2010; Rosayuru et al., 2019; Roy et al., 2018)	4	Poor relationship between stakeholders	(Durdyev et al., 2020; Roy et al., 2018)	2	Lack of input provided on constructability and installation processes	(Durdyev et al., 2020; Othman & Youssef, 2020)	2	Institutional inertia	(Ghassemi & Becerik-Gerber, 2011; Rowlinson, 2017)	2	Confusion and misunderstandings regarding accounting of contingency	(Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Roy et al., 2018)	2	Unavailability of technological support	(Durdyev et al., 20	1
9	Conflict due to multi-party agreement throughout the project lifecycle	(Othman & Youssef, 2020; Roy et al., 2018)	2	Cultural barriers in different countries/industries	(Ghassemi & Becerik-Gerber, 2011; Rosayuru et al., 2019)	2	Late decision and unclear expectations by the client	(Durdyev et al., 2020; Othman & Youssef, 2020)	2	Improper selection of IPD-oriented design team	(Othman & Youssef, 2020)	1	Concerns regarding risk sharing and open-book accounting	(Kent & Becerik-Gerber, 2010; Roy et al., 2018)	2	Lack of utilisation of BIM	(Durdyev et al., 20	1
10	Fuzzy definitions	(Abdirad & Dossick, 2019; Durdyev et al., 2020)	2	Language barriers	(Rosayuru et al., 2019)	1	Lack of commitment by government officials	(Azhar et al., 2015; Durdyev et al., 2020)	2	Lack of participation of government agencies in the construction of the project	(Kahvandi et al., 2018)	1	Lenders may demand 'hard pricing' precluding IPD	(Elghaish, Abrishami, Hosseini, & Abu-Samra, 2020; Roy et al., 2018)	2	Integration of information and knowledge management systems	(Roy et al., 2018)	1
11	Lack of legal and contractual support	(Durdyev et al., 2020; Ghassemi & Becerik-Gerber, 2011)	2	Lack of favourable market culture	(Durdyev et al., 2020)	1	Lack of giving priority to the project lifecycle	(Othman & Youssef, 2020)	1	Lack of experience of the contractor for early presence in the project	(Kahvandi et al., 2018)	1	The existing accounting system is unclear and unreadable for all IPD core team members	(Elghaish & Abrishami, 2021)	1			
12	Legal risk of moving from 2D-3D	(Kent & Becerik-Gerber, 2010; Roy et al., 2018)	2	Steep learning curve in IPD projects	(Durdyev et al., 2020)	1	Shorter projects cannot spend time on organisational efforts for IPD	(Othman & Youssef, 2020)	1	The effect of weak matrix structure	(Kahvandi et al., 2018)	1	Need for continuous estimation feedback to accomplish the pre-construction IPD stages	(Elghaish & Abrishami, 2021)	1			
13	Lack of existence of conditions to assign the liability insurance to the contractor	(Kahvandi et al., 2018)	1	Architects' perception of reduction in control of design and planning	(Abdirad & Dossick, 2019)	1	Unwillingness of stakeholders to conduct the project under common interests	(Othman & Youssef, 2020)	1	Timing of key participant involvement	(Roy et al., 2018)	1	Need for detailed estimation technique to ensure that the contractor does not hide any profit into overhead cost	(Elghaish & Abrishami, 2021)	1			
14	Lack of homologous contracts among sub-contractors	(Kahvandi et al., 2018)	1				Retaining the right of final decision for the client	(Othman & Youssef, 2020)	1	Early involvement of subcontractors	(Roy et al., 2018)	1	Requirement of an automated system to ensure that all profits and risks will move to the profit/risk pools accurately	(Elghaish & Abrishami, 2021)	1			
15	Lack of proper definition of the culture of teamwork among stakeholders	(Kahvandi et al., 2018)	1				Difficulties in performing and managing collaborative work because of frequent communication and the large number of involved participants	(Ma et al., 2018)	1				Selecting the compensator for financial losses	(Kahvandi et al., 2018)	1			
16	Disparity in contract management	(Nwajei, 2021)	1				Lack of proficiency and strong management of the employer	(Kahvandi et al., 2018)	1				High embedded risks	(Durdyev et al., 2020)	1			
17	How to handle third party claims	(Roy et al., 2018)	1				Lack of appropriate orientation for future and inattention to the future development	(Kahvandi et al., 2018)	1				Long-term resiliency issues that put investment at risk	(Durdyev et al., 2020)	1			
18	Aspirational language in contract	(Roy et al., 2018)	1				Procurement difficulties	(Durdyev et al., 2020)	1				High initial investment	(Durdyev et al., 2020)	1			
19	Contract language reflecting scars of prior battle	(Roy et al., 2018)	1				Lack of well-conducted kick-off meetings	(Durdyev et al., 2020)	1				High bids due to inexperience	(Roy et al., 2018)	1			
20							Early definition of target goals without fully developed design	(Roy et al., 2018)	1				Absolute financial limitation of owner	(Roy et al., 2018)	1			
21							Intensive meetings in IPD	(Roy et al., 2018)	1				Lack of funding as an initial investment	(Rosayuru et al., 2019)	1			
22							Joint ownership of documents	(Roy et al., 2018)	1									
23							Selecting the right team early and based on quality/values	(Roy et al., 2018)	1									
24							Limitation in the choice of contractors	(Rosayuru et al., 2019)	1									

6.1. Cost performance

IPD has superior cost performance compared to traditional PDSs (DBB, DB, and CMR) in evaluations 2, 3, 12, 20, and 21 in Table 5, however, other evaluations (6, 7, 9, 19, 22, and 23 in Table 5) with high sample sizes assert that there are no significant differences among the examined PDSs. IPD projects are completed within the budget or with a cost-saving according to 11 evaluations (5, 10, 13, 14, 15, 24, 25, 26, 27, 29, and 30 in Table 5). Only 3 evaluations (1, 11, and 28 in Table 5) indicate that there is a cost overrun in an IPD project. It can be concluded that IPD has no superiority over traditional PDSs concerning cost performance, however, IPD could provide a significant improvement in cost management at least by eliminating cost overruns.

6.2. Time performance

IPD has superior time performance compared to traditional PDSs in evaluations 2, 3, 7, 8, 12, 16, and 21 in Table 5, however, some evaluations (6, 9, 19, 20, and 22 in Table 5) assert that there are no significant differences among the examined PDSs. IPD projects are completed within the schedule or with a time-saving according to 11 evaluations (1, 4, 13, 14, 15, 25, 26, 29, 30, 32, and 33 in Table 5). Only 3 evaluations (24, 27, and 28 in Table 5) indicate that there is a delay in an IPD project. It can be concluded that IPD has a slightly superior schedule performance over traditional PDSs. Most of the time performance outcomes are positive regarding IPD implementation, and IPD could improve schedule predictability.

6.3. Communication performance

It is found that IPD has superior communication performance compared to traditional PDSs in all of the communication evaluations. According to the identified studies, the number of RFIs, the number of resubmittals, RFI processing time, and rework are decreased. Further, IPD projects provide a significant improvement in collaboration and relationships.

6.4. Other performance areas

8 of 33 evaluations provide findings in quality performance, and most of the evaluations (3, 7, 8, 12, 17, and 22 in Table 5) assert that IPD has superiority over traditional PDSs regarding quality performance.

All of the evaluations (7, 8, 9, 16, 22, 24, 25, 27, 28, and 32 in Table 5), which examine change management performances, indicate that IPD has superiority over traditional PDSs regarding change management performance. Further, there are fewer changes, quick decision-making, and flexibility for changes in IPD projects.

IPD has positive and superior business performance in all of the evaluations (7, 9, 14, 16, 17, 23, 25, 27, and 29 in Table 5) which examine business performances. In the identified studies, it is indicated that IPD provides increased market opportunities, fewer claims, pleased owner, long-term reliability.

There are only 4 evaluations regarding HSE performance among 33 identified evaluations, and no significant differences in HSE performances are determined. For the evaluation of HSE performance, we can note that the number of studies in the literature is insufficient.

7. Conclusion

This research conducted a systematic literature review in four steps, which included bibliometric search, scientometric analysis, an in-depth literature review, and a discussion about the performance outcomes of IPD.

In the bibliometric analysis, studies on IPD are examined in two extensive databases, Scopus and WoS. The combined data set including 207 publications is firstly analyzed in terms of publication years, and it is found that there are only 3 articles related to the identified research areas before 2000, and there are more than 10 articles per year after 2013. Further, it is observed that Ling, F. Y. Y is the most productive researcher with 11 articles related to the identified keywords, and United States has the highest number of articles. Moreover,

Table 5. The performance outcomes of IPD in the AEC sector.

Nu.	Studies	Sam. Sizes	Project Names/Types	Countries	Years	Project Delivery Systems	Findings in Performance Areas						
							Cost	Time	Quality	Communication	Change Management	Business	Health, Safety and Environ.
1	(AIA, 2012; AIA California Council, 2010; Kahvandi et al., 2018)	1	The Walter Cronkite School of Journalism	USA	2006-2008	DB + IPD Principles	10.1% Overrun	1 Month Earlier	-	Inc. Collab.	-	-	-
2	(Kahvandi et al., 2018)	2	A hospital project with 96 beds	-	2007	CMR	3.13% Saving	11 Days Delay	-	-	-	-	-
			A hospital project with 103 beds	-	2010	IPD	10.27% Saving	81 Days Earlier	-	-	-	-	-
3	(Kahvandi et al., 2018; Mesa et al., 2016)	1	A hospital project	USA	-	DBB	25% Overrun	6 Months Delay	5 out of 10	-	-	-	-
			A hospital project	USA	-	DB	4.4% Overrun	1 Month Delay	7 out of 10				
			A hospital project	USA	-	CMR	9.4% Overrun	2 Months Delay	6 out of 10	-	-	-	-
			A hospital project	USA	-	IPD	6.9% Saving	2 Months Earlier	8 out of 10	-	-	-	-
4	(Durdyev et al., 2020; Hall & Scott, 2019; Zhang, Huang, & Peng, 2018)	-	Sutter Medical Center in Castro Valley	USA	-	IPD	-	30% Faster than DBB	-	-	-	-	-
5	(Hanna, 2016)	1	The Orlando Utilities Commission North Plant	USA	-	IPD Principles	10% Saving	-	-	-	-	-	-
6	(Cho & Ballard, 2011; El Asmar et al., 2013; Hanna, 2016; Kelly & Ilozor, 2022)	49	- (Study by Cho and Ballard (2011))	-	-	IPD (9) vs non-IPD (40)	No Signif. Differ.	No Signif. Differ.	-	-	-	-	-
7	(El Asmar et al., 2016; El Asmar et al., 2013; Hanna, 2016; Ibrahim et al., 2020; Kelly & Ilozor, 2022; Laurent & Leicht, 2019; Yu et al., 2019; Zhang, Huang, & Peng, 2018)	35	%50 healthcare project, %25 university laboratory, %25 other (Study by El Asmar et al. (2013))	USA	2005-2012	IPD (12) vs non-IPD (23)	No Signif. Differ.	Superior IPD	Superior IPD	Superior IPD	Superior IPD	Slightly Superior IPD	No Sig.. Diff. in Saf. Sup. IPD in Envir.
8	(Hanna, 2016; Ibrahim et al., 2020)	32	- (Study by Iwanski and Hanna (2013))	-	-	IPD vs non-IPD	-	Superior IPD	Superior IPD	Superior IPD	Superior IPD	-	-
9	(Hanna, 2016; Ibrahim et al., 2020; Kelly & Ilozor, 2022)	-	- (Study by Hanna (2016))	USA	-	IPD (9%) vs non-IPD (91%, DBB-DB-CMR)	No Signif. Differ.	No Signif. Differ.	No Signif. Differ.	Superior IPD	Superior IPD	Superior IPD	No Signif. Differ.
10	(Ballard et al., 2015)	46	- (Study by Ballard et al. (2015))	-	-	IPD	In Budget (44) 7.25% Overrun (2)	-	-	-	-	-	-
11	(Ballard et al., 2015)	1	A hospital project	-	2010	IFOA	6.4% Overrun	-	-	-	-	-	-
12	(Singleton & Hamzeh, 2011)	2	Pentagon Renovation Program (1/5 of the building)	USA	1998	DBB	Over Budget	Behind Schedule	-	-	-	-	-
			Pentagon Renovation Program (remaining part)	USA	-	FPIF + FPAF + IPD Principles	Under Budget	Goals Met	Goals Met	-	-	-	Goals Met
13	(Andary et al., 2020; Matthews & Howell, 2005; Singleton & Hamzeh, 2011)	1	North Chiller Plant	USA	2003	DB + GMP + IPD Principles	10% Saving	Goals Met	-	-	-	-	-
14	(AIA, 2012; Singleton & Hamzeh, 2011)	1	Cathedral Hill Hospital, 555 beds	USA	2007-2015	IFOA	Cost Savings	Goals Met	-	Inc. Collab.	-	Incr. Market Opport.	-
15	(Chan et al., 2016)	1	A public drainage project	Hong Kong	2006	NEC3-based RC + IPD Principles	5% Saving	6 Months Earlier	-	-	-	-	-
16	(Schroeder, 2014)	2	A monumental structure	USA	-	GC/CM (Close to DBB)	-	On Time	-	-	-	-	-
			A monumental structure	USA	-	CM/GC (Close to IPD)	-	3 Months Earlier	-	-	Fewer Changes	Fewer Claims	-
17	(Paik et al., 2017)	2	A small-scale office building project	USA	-	CMR (Owner changed IPD to CMR.)	-	-	Poor Quality	Average	-	Average	-
			A institutional renovation project	USA	-	IPD	-	-	Adeqaute	Adeqaute	-	Adeqaute	-
18	(Kokkonen & Vaagaasar, 2018)	1	Two hospital buildings with 289 beds and an energy centre	USA	2007-2015	IPD Principles (Separate contracts)	-	-	-	Inc. Collab.	-	-	-
19	(Kelly & Ilozor, 2022)	93	- (Study by Kelly and Ilozor (2020))	-	-	IPD (18) vs non-IPD (75)	No Signif. Differ.	No Signif. Differ.	No Signif. Differ.	-	-	-	-
20	(Kelly & Ilozor, 2022)	49	- (Study by Kelly and Ilozor (2013))	-	-	IPD (7) vs non-IPD (42)	Superior IPD	No Signif. Differ.	-	-	-	-	-
21	(Kelly & Ilozor, 2022)	72	- (Study by Nguyen and Akhavian (2019))	-	-	IPD + Lean (55) vs non-IPD (17)	Superior IPD	Superior IPD	-	-	-	-	-
22	(Ibrahim et al., 2020)	109	%43 institutional, %31 industrial, %20 commercial, %6 other (Study by Ibrahim et al. (2020))	USA (%88), Other (%12)	2010-2019	IPD (17%) vs non-IPD (83%, DBB DB-CMR)	No Signif. Differ. (Superior than DBB)	No Signif. Differ. (Superior than DBB)	Superior IPD	Superior IPD	Superior IPD	-	No Signif. Differ.
23	(Choi et al., 2019)	17	Healthcare projects (Study by Choi et al. (2019))	USA	2009-2014	IPD (8) vs CMR (9)	No Signif. Differ.	-	-	Superior IPD	-	Superior IPD	-
24	(AIA, 2012; AIA California Council, 2010)	1	Autodesk AEC Solutions Division Headquarters, Interior Office Fit-Out	USA	2008-2009	IPD	Under Budget (0.9% Saving)	38 Days Delay	-	Inc. Collab.	Quick Decisions	-	-
25	(AIA, 2012; AIA California Council, 2010)	1	Sutter Regional Medical Foundation Medical Office Building	USA	2005-2007	IFOA	Under Budget (0.6% Saving)	Within Schedule	-	Inc. Collab.	Fewer Changes	Pleased Owner	-
26	(AIA, 2012; AIA California Council, 2010)	1	SSM Cardinal Glennon Children's Medical Center	USA	2004-2007	IFOA	In Budget	2 Months Earlier	-	-	-	-	-
27	(AIA, 2012; AIA California Council, 2010)	1	SSM St. Clare Health Center	USA	2005-2009	IFOA	In Budget	4 Months Delay (Due to Owner's Change)	-	Inc. Collab.	Flexibility for Changes	Pleased Owner	-
28	(AIA, 2012; AIA California Council, 2010)	1	Encircle Health Ambulatory Care Center	USA	2006-2009	IFOA	Over Budget (1.2% Overrun)	1 Month Delay	-	Inc. Collab.	Fewer Changes	-	-
29	(AIA, 2012)	1	MERCY Master Plan Facility Remodel, Healthcare - Renovation	USA	2010-2013	IPD	In Budget	Increased Schedule Predictability	-	Inc. Collab.	-	Getting Long-Term Reliability	-
30	(AIA, 2012)	1	Lawrence & Schiller Remodel, Office – Renovation	USA	2010	IPD	10% Cost Saving Expected Over DB	20% Time Saving Expected	-	-	-	-	-
31	(AIA, 2012)	1	SpawGlass Austin Regional Office	USA	2010	IPD	-	-	-	Inc. Collab.	-	-	-
32	(AIA, 2012)	1	Edith Green Wendell Wyatt Federal Building Modernization, Office - Renovation	USA	2009-2013	CMC + IPD Principles	-	Within Schedule	-	Inc. Collab.	Fewer Changes, Flexibility for Chan.	-	-
33	(AIA, 2012)	1	USCF Mission Bay Medical Center	USA	2007-2014	Multiple Indepen. Contracts + IPD Princ.	-	Within Schedule	-	Inc. Collab.	-	-	-

53.1% of the articles included in the bibliometric analysis is on the subject of engineering, and 41.0% of the articles is on the subject of business, management, and accounting.

In the scientometric analysis, the chosen studies are assessed using VOSviewer software. By conducting co-authorship analysis, it is found that Ling, F. Y. Y. has the strongest linkage, and Kumaraswamy, M. M. is the second author in strong collaboration with colleagues. In co-occurrence analysis, it is observed that the most frequently used author keywords are "integrated project delivery", "relational contracting", and "collaboration". In addition, it is observed that Australia, United States, Hong Kong, and United Kingdom have the strongest linkage among the other countries.

In the comprehensive literature review part, definitions, principles, benefits, and barriers of IPD are reviewed and classified.

In the last part, findings in 7 performance areas are analyzed by reviewing the identified studies. Most of the performance evaluations are based on a single sample, and the rate of IPD cases is low in sample sizes. Almost all of the studies are performed in United States, and the oldest performance evaluation for IPD is in 2003. Further, IPD has largely been implemented in healthcare projects.

It can be concluded that IPD has no superiority over traditional PDSs concerning cost performance, however, IPD could provide a significant improvement in cost management at least by eliminating cost overruns. Moreover, IPD has a slightly superior schedule performance over traditional PDSs. Most of the time performance outcomes are positive regarding IPD implementation, and IPD could improve schedule predictability. Furthermore, IPD has superior communication performance compared to traditional PDSs in all of the evaluations. According to the identified studies, the number of RFIs, the number of resubmittals, RFI processing time, and rework are decreased. Further, IPD projects provide a significant improvement in collaboration and relationships. In addition, most of the evaluations assert that IPD has superiority over traditional PDSs regarding quality performance. Moreover, all of the related evaluations indicate that IPD has superiority over traditional PDSs regarding change management performance, and there are fewer changes, quick decision-making, and flexibility for changes in IPD projects. Additionally, IPD has positive and superior business performance in all of the related evaluations, and it is indicated that IPD provides increased market opportunities, fewer claims, pleased owner, long-term reliability. Lastly, there are only 4 evaluations regarding HSE performance among 33 identified evaluations, and no significant differences in HSE performances are found.

IPD presents a potential solution to challenges faced in conventional project delivery methods. While IPD provides significant benefits, its application is still relatively rare globally, and there are obstacles to its adoption. Findings show that IPD provides desirable performance outcomes in most of the performance areas, however, some advantages of IPD, which are projected in the literature such as increased profit, fewer injuries, higher sustainability, are not supported by the identified evaluations of IPD cases. IPD approach can attract practitioners' attention in the AEC sector in case well-documented studies are published and advantages are explained exactly. With the rising popularity of IPD and its potential as an effective approach, upcoming research directions may focus on real cases that highlight the main and optional IPD principles established in this study. Further, IPD implementation knowledge could be increased by future research in different types of projects, and future studies need to expand the data set in different geographical locations.

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