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# Interactions of factors affecting the implementation of Integrated Project Delivery in the New Zealand construction industry: a system dynamics and network analysis approach

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## ABSTRACT

Integrated Project Delivery (IPD) is a collaborative project delivery approach that brings together people, systems, and practices to reduce waste, enhance sustainability, and improve project outcomes. This study examined the factors and their interactions hindering IPD implementation in New Zealand (NZ) through 18 semi-structured interviews with local construction professionals. Using manual coding and VENSIM visualisation, the study identified key challenges and their interactions. Critical factors include resistance to change, low technology adoption, high initial investment costs, insufficient mutual respect and trust, client's resistance, and lack of industry standardisation. Key challenges in NZ include a lack of information on IPD outcomes, a limited number of contractors and consultants, governance conflicts, a preference for traditional models, resistance to change among experienced professionals, contractor liquidations, subcontractors taking main contractor roles, and project size. The research used network analysis methods, such as degree and eigenvector centrality, and causal chain analysis to identify critical factors and chains affecting IPD uptake. The findings compare NZ's challenges with global experiences, highlighting both unique and common obstacles. While the limited sample size (18 professionals) is a constraint, the research provides insights to help researchers and practitioners address factors and their interactions to support sustainable construction practices in NZ.

## ARTICLE HISTORY

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## KEYWORDS



Integrated Project Delivery (IPD); factors; interactions; system dynamics; network analysis


## Introduction

Integrated Project Delivery (IPD) has been attracting growing attention across academia and the construction industry (Mesa *et al.* 2016). The American Institute of Architects describes IPD as a project delivery approach that integrates people, systems, business structures, and practices into a process that collaboratively utilises the skills and opinions of all project participants to enhance project results, increase value to the owner, reduce waste, and maximise efficiency through all stages of design, fabrication, and construction (AIA 2007). IPD involves the early involvement of all key participants and aims to minimise waste in construction projects, leading to improvements in cost, schedule, and quality (Matthews and Howell 2005), while

promoting collaboration through mutual respect and trust (Pishdad-Bozorgi and Beliveau 2016). Documented case studies reveal that IPD can save 2–10% of total project costs, with savings of up to 30% expected if the project team successfully integrates strategic partnering (Zhang *et al.* 2018). IPD is widely regarded as a modern project delivery approach in the construction industry, providing the most effective and efficient way to procure built assets (Rowlinson 2017).

Furthermore, IPD can enhance the success of constructing greener buildings by promoting efficient use of essential resources and waste reduction, thereby advancing sustainability (Ghassemi and Becerik-Gerber 2011). However, IPD challenges the project team, making its implementation difficult (Naismith *et al.* 2016).

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While much of the literature investigates IPD factors, the interactions between them remain a research gap. This research identifies factors that constitute barriers to the implementation of IPD. A comprehensive study of the interactions between factors has yet to be conducted. It is essential to recognise that the factors of IPD do not operate in isolation; instead, they interact with other factors within the factor network, thereby amplifying their impact on its implementation. Interactions between factors in IPD implementation represent a significant research gap and have been only briefly explored before (Bin Asad *et al.* 2024). This research aimed to fill this gap by identifying and highlighting the interactions of factors affecting IPD in New Zealand (NZ).

### **The NZ construction industry**

The profile of the NZ construction industry is similar to that of other, larger countries. The NZ construction sector is primarily composed of small, micro, and medium-sized companies (Seadon and Tookey 2019). 32.5% of the ~60,000 operating businesses are considered small (1–19 employees), and 65% are sole traders. Further, over 150 industry bodies and subsector groups, in addition to governmental, consenting, and regulatory bodies, add to the background (MBIE 2020). In 2020, the NZ construction industry ranked 4th among the top 10 sectors by value added nationally, contributing 6.7% to GDP, or \$12.3 billion (Stats NZ 2021). The performance of the construction industry is an essential driver of growth in the NZ economy (Seadon and Tookey 2019). The NZ government is a major client in the construction industry, focusing on developing basic infrastructure, including roads, dams, drainage systems, educational institutions, residences, and industrial facilities (Moshood *et al.* 2024). Additionally, the NZ government is committed to advancing the national economy; several reforms have been implemented to ensure the success of all major construction projects (Abdullah *et al.* 2010).

However, the NZ construction industry has been suffering from low productivity, scheduling delays, quality issues, limited organisational flexibility, high enterprise failure rates, increased transaction costs, and unpredictability in project delivery (Chang-Richards *et al.* 2019). Sectoral reviews have identified supply-chain issues and the lack of integration and collaboration as significant challenges impacting the NZ construction industry (MBIE 2020). Zaiat *et al.* (2019) study of a medium-sized company in the NZ construction industry found that factors preventing

effective collaboration within the company included issues such as open communication among project participants and differing mindsets. To overcome these fragmentation and collaboration issues, the NZ construction industry would benefit from greater adoption of collaborative project delivery models.

### **Collaborative project delivery practices within the NZ construction industry**

In the construction context, the “collaborative approach” has been discussed in relation to Partnering, Alliancing, and IPD (Walker and Lloyd-Walker 2015). Alliancing has been integrated into large-scale transport infrastructure projects to enhance stakeholder engagement and project efficiency (Baharuddin *et al.* 2017). The recent surge in projects completed and underway under the NZ Transport Agency (NZTA)’s management marks a significant advancement in the evolution of Alliancing in NZ (Ibrahim *et al.* 2016). Although Alliancing practices are already more innovative than those of other delivery models, the organisational maturity has further advanced the field by introducing new procurement methodologies tailored to the needs of individual projects. These progressive approaches have elevated Alliancing to a new standard in NZ. For example, Alliances now run in extended interim phases while maintaining collaborative behaviours essential for project success. Further innovations include the appointment of an independent Alliance Manager and the incorporation of the local council as an Alliance partner; this is particularly useful where public engagement is a major concern (Ibrahim *et al.* 2016). Additionally, researchers in NZ have made significant contributions by developing innovative Alliance practices tailored to the country’s national context. Che Ibrahim *et al.* (2017) found that Alliancing projects in NZ often feature unique governance structures, innovative functional teams, and customised risk/reward frameworks that support creative, client-focused solutions. These innovations have pioneered Alliancing beyond traditional models and offer valuable lessons on how adaptable procurement policies and collaborative leadership can drive breakthrough project outcomes (Che Ibrahim and Aaltonen 2025). The significance of effective stakeholder management, a feature of Alliancing, was highlighted by Baharuddin *et al.* (2017) in their research; the Alliance procurement approach supported successful stakeholder engagement in a NZ megaproject by fostering a

culture of care, transparent communication, and responsiveness.

However, there have been fewer attempts to implement IPD in NZ, and there is limited prior research on the barriers to its implementation (Naismith *et al.* 2016). Lean Construction (LC), which underpins the IPD model, has seen declining adoption in NZ due to fewer practitioners using lean tools (Likita *et al.* 2022). Lean tools are implemented only on sites where they have been formally introduced, typically by experienced practitioners who are encouraged to maintain their use. Likita *et al.* (2022) report that LC in NZ is primarily theoretical rather than practical, and some organisations may apply LC principles without explicitly identifying them as such. The construction industry also experiences a shortage of skilled LC practitioners. Key barriers to LC adoption in NZ include unfamiliarity with lean concepts, misunderstandings, and technological challenges (Vilasini *et al.* 2014, Evans *et al.* 2020). Although research on LC is available, studies on IPD in NZ remain limited. This study addresses the following research questions (RQ):

**RQ 1:** Why is IPD scarcely implemented in NZ?

**RQ 2:** What are the interactions between factors that impact the implementation of IPD in NZ?

**RQ 3:** How do the IPD implementation challenges in NZ align with and differ from those in other countries and regions?

## Literature review

Studies on IPD-related delivery methods commenced in the 1960s, when the concept of “integration” in project delivery methods attracted the attention of academics and researchers (Mesa *et al.* 2016). Milestone concepts such as the Program Evaluation and Review Technique (PERT), introduced in the 1950s, the General Architectural Reference Model (GARM), introduced in the 1980s, and practices like Gemba Kaizen represent critical steps toward integrated delivery. From the 1980s onwards, relational contracting approaches such as the Lean Project Delivery System (LPDS), Alliancing and Partnering gained recognition. Alliancing contracting has been widely recognised in Australia, while Partnering has found similar success within the UK construction industry, particularly in healthcare projects (Arar *et al.* 2025). IPD, as it is known today, was first introduced as a project delivery method by Sutter Health, a leading healthcare provider in Northern California. In 2004, Sutter Health aimed to

address the issues with healthcare construction projects in the United States by developing a contracting method that supports Lean Project Delivery (Lichtag 2005). To achieve this goal, an integrated agreement was drafted that bound the owner, design team, and general contractor into a single design and construction contract (Lichtig 2006). This initial agreement consisted of a financial incentive strategy borrowed from the Alliancing model (Sakal 2005), which enabled stakeholders to use alternative dispute resolution and to waive liability for damages mutually (Darrington and Lichtig 2010). The Sutter Health project was completed successfully, executed below the estimated cost, and resulted in increased stakeholder satisfaction compared to their previous projects (Rankohi *et al.* 2023). This initiated the current era of IPD (Lahdenperä 2012). However, the period of theorisation is continuing, and IPD is still considered immature (Hall *et al.* 2022). Several researchers consider IPD a standalone delivery model, while others view it as a philosophy applicable across various delivery models (Rankohi *et al.* 2023). The advantages of IPD are achieved through integration and are therefore distinct from those of non-IPD projects (Aldossari *et al.* 2023). The differences between traditional project delivery and IPD can create barriers due to resistance from the wider community. Nevertheless, industry professionals with prior integration experience have embraced some elements and amendments. Although the amendments required to adopt IPD may create significant barriers to its implementation, industry professionals’ awareness of these barriers may vary according to the degree of integration experience they have gained (Ma *et al.* 2022).

Despite the introduction of IPD in the United States through the Sutter Health project, statistics have shown a slow uptake of IPD in the country. Previous research has linked the slow adoption to the lack of contractual understanding and implementation of the IPD method (Ahmed *et al.* 2021). Bilbo *et al.* (2014) identified that non-fully understood contracts are among the main obstacles to IPD implementation. Additionally, Roy *et al.* (2018) reaffirmed the findings, revealing that the noncomprehensive understanding of contracts is among the major challenges to IPD implementation. The AIA C-191 and ConsensusDocs 300 are among the most popular IPD contracts in the United States (Ahmed *et al.* 2021). Under the AIA C-191 contract, IPD is described as a method through which the parties intend to deliver the project in a collaborative

environment, share skills, knowledge, and services during all project phases, and cooperate to achieve mutually agreed-upon project goals.

Furthermore, the AIA C-191 contract divides the IPD management structure between two teams: the project executive team and the project management team. The project executive team is responsible for overall project management, while the project management team implements the decisions made by the project executive team. The AIA C-191 contract consists of eight phases: the conceptualisation phase, the criteria design phase, the detailed design phase, the implementation documents phase, the agency review phase, the buyout phase, the construction phase, and the closeout phase (Ahmed *et al.* 2021). Under the ConsensusDocs 300 contract, IPD is defined as a method through which each party promises to (1) organise and share their respective expertise, responsibilities, and roles, (2) commit to transparent decision-making, open communication, and problem-solving, (3) align and identify their respective objectives and expectations, (4) enhance design, planning and construction of the project, and (5) share rewards and risks target achievement of project objectives. The ConsensusDocs 300 contract divides the IPD management structure into the IPD team, the core group, and the senior executive team. The IPD team consists of the main and joining parties. The core group, considered the management and decision-making body, consists of at least a representative from each of the main parties. Lastly, the senior executive team, which comprises a representative from each party in the core group, provides executive mentorship and support to the core group. Finally, the ConsensusDocs 300 contract consists of three phases: the validation phase, the preconstruction phase, and the construction phase. The precursors to IPD, such as Alliancing and Partnering, emphasised multi-party agreements, mutual risk and reward sharing, and the fostering of collaboration among project participants (Rodrigo 2012). Although features such as the Big Room environment and the use of Building Information Modelling (BIM) are frequently recognised as unique mechanisms of the IPD model, their application within the IPD framework varies depending on the project's complexity and the agreements between connected parties. This flexibility suggests that these features should not be considered conclusive distinguishing features of IPD from other types of relational contracting models. Therefore, the central concept of IPD lies in

its foundational contractual and operational framework, which promotes collective decision-making and risk-reward sharing, and considerably overlaps with other types of relational contracting models (Arar *et al.* 2025).

LC, BIM, and co-location are essential components for the successful implementation of the IPD model (Rodrigues and Lindhard 2021). IPD is considered a preferable delivery model for implementing LC principles, as it complements lean methods such as target value design and the last planner system (Lichtig 2006). LC principles resonate well with the IPD model, as both emphasise collaboration, communication, and trust, ultimately improving project performance (Cheng and Johnson 2016). BIM and co-location fit well into this context as both support collaboration and communication (Andary *et al.* 2020). Co-location aids collaboration and communication by bringing key stakeholders together, and BIM supports it through real-time sharing of information and models (Latiffi 2013). IPD serves as a desirable framework for integrating BIM and LC, where BIM, co-location, and LC are important enablers that, combined with the behavioural elements and contractual framework of IPD, can contribute to better project outcomes (Rodrigues and Lindhard 2021). IPD relies heavily on effective communication and coordination among project participants. Information and communication technology can facilitate the implementation of IPD by enhancing communication (Azhar *et al.* 2015). Several other studies have reaffirmed the importance of BIM in IPD implementation. In a healthcare project case study utilising BIM and IPD, Dossick *et al.* (2013) found that the BIM kiosk served as an information hub and strengthened collaborative norms. Al Hattab and Hamzeh (2013) identified that the best outcomes in the construction industry can be achieved through the combined use of BIM, lean, and IPD. In Australia, the use of BIM has increased through its mandatory application in public sector projects. However, IPD and lean are not experiencing similar growth (Patching *et al.* 2024). In recent literature on the interplay between BIM and IPD, Karasu *et al.* (2023) proposed that the clusters of sustainability, transformation, and increasing the competence level of staff in the Architecture, Engineering, and Construction industry, in addition to the concept of quality, require more extensive research in the context of BIM and IPD. Sherif *et al.* (2022) argued that technology is available, but the intent to utilise it is low. The behavioural elements of respect, trust, willingness to collaborate, and open

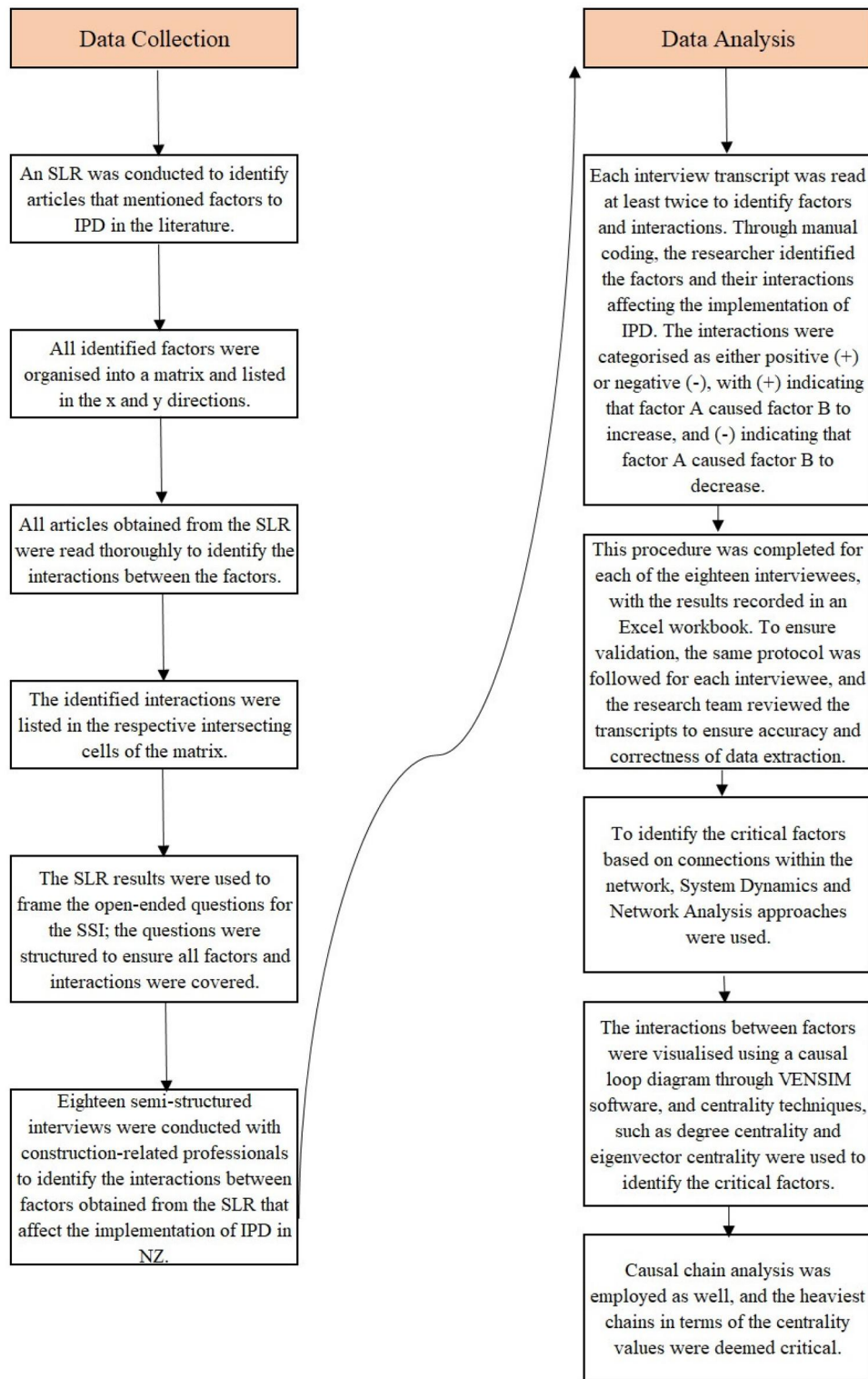
communication are essential for IPD implementation (Rodrigues and Lindhard 2021).

The features of an IPD contract include early involvement of key participants, fiscal transparency, intensified planning and design, shared risk and reward, joint project control, jointly developed and validated targets, multiparty agreements, and reduced liability exposure. At a minimum, an IPD contract requires early collaboration among the owner, designer, contractor, and other parties, depending on the project's complexity (AIA 2014). Fiscal transparency means that the main project participants, such as the owner, designer, and contractor, keep the books open. This financial transparency increases collaboration and trust among the main project parties (Ahmad *et al.* 2019). The intensified planning and design feature of IPD refers to improving the quality of plans and designs (Kenig *et al.* 2010). By intensifying the project's planning and design, the project's cost, time, and quality aspects are enhanced (Larsen *et al.* 2018). In terms of shared risk and reward, IPD contracts involve an individual's profit being put at risk and proportionate to the overall project performance, as compensation is linked to the attainment of project objectives (AIA 2014). The owner is responsible for the payment of direct costs; however, the profit is adjusted between the IPD team by comparing the total project direct costs with an agreed target (Fischer *et al.* 2017). The joint project control feature of an IPD contract concerns the sharing of project control among the owner, designer, and contractor, intended to balance the parties' interests and strengthen the project's collaborative nature (AIA 2014). The jointly developed and validated targets feature of IPD contracts consists of the targets, developed collaboratively by the owner, designer, and contractor, to define the project's key goal regarding project performance (Rodrigues and Lindhard 2021). The multi-party agreement feature of an IPD contract binds, at a minimum, the owner, designer, and contractor into a single agreement. Finally, reduced liability exposure in an IPD contract refers to the reduced ability of the IPD team to sue one another (Fischer *et al.* 2017). In the general literature, the common themes related to IPD implementation factors include collaboration (CC), financial (F), governmental/political (GP), legal (L), organisational (CO), and technological (T) (Bin Asad *et al.* 2023).

Additionally, the current construction environment is not conducive to IPD implementation due to existing industrial, cultural, legal, and political issues. To allow IPD implementation in a public project, the legal system should allow the client to enter into a single

multiparty agreement with the architect and the contractor (Sherif and Abotaleb 2022). Furthermore, the lack of insurance policies and an effective risk allocation mechanism poses additional legal challenges for IPD implementation (Sherif and Abotaleb 2022). Moreover, Ahmed *et al.* (2021) suggested that the key areas of concern in the contractual management of IPD include data sharing, dispute resolution, insurance, liabilities and indemnification, risks and incentives, and suspension and termination. Additionally, cultural issues such as reluctance to share information, decision-making power, and resistance to change can create additional challenges for IPD implementation (Ma *et al.* 2022). The high upfront investment requirement for IPD has sparked debate over project size and complexity, with some researchers arguing that inadequately sized projects cannot recoup the high upfront investments (Cohen 2010). However, subsequent studies disagreed, including Cleves and Dal Gallo's (2012) study, which noted several successful IPD projects. Finally, the lack of government support is another factor in the implementation of IPD. Rowlinson (2017) acknowledged that the government does not provide sufficient support for IPD implementation. The impact of specific IPD factors varies from country to country, with certain factors holding more prominence in certain countries. For example, Ma *et al.* (2022) found that participants from China identified the lack of government support as a significant factor in IPD implementation, whereas participants from Singapore did not.

While many studies have identified factors to IPD implementation, their interactions remain underexplored. Understanding these interactions provides deeper insight into how factors relate, expands existing knowledge into new contexts, and supports more accurate predictions (Andersson *et al.* 2014). The main challenge is the limited understanding of how these factors combine to affect IPD outcomes. Recognising these interactions reveals their collective impact and helps develop models that reflect real-world complexity (Bala *et al.* 2017). Without this perspective, examining factors in isolation may lead to oversimplified or inaccurate conclusions. Identifying how IPD factors interact can improve decision-making, enabling targeted strategies and more accurate predictions (Bala *et al.* 2017). These interactions reveal both positive and negative relationships that may be missed if factors are considered individually. This research addresses a gap in the NZ construction industry: a lack of a comprehensive analysis of IPD factor interactions. Only one brief study by Naismith *et al.* (2016)



**Figure 1.** Flowchart detailing an overview of the methodology. *Source:* Author's own work.

has examined IPD in NZ's public sector. Despite growing interest, the literature often overlooks key factors in relationships that affect IPD success in NZ. This lack of analysis limits the development of a robust research framework for the unique dynamics of IPD in NZ.

Addressing this will provide actionable insights and guidance for practitioners and researchers. IPD factors do not act independently; their interactions amplify their collective influence on implementation. Investigating these relationships will clarify how they

**Table 1.** SLR inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Articles mentioning barriers to Integrated Project Delivery	Non-Integrated Project Delivery and construction-related articles
English language papers	Articles without mention of barriers to Integrated Project Delivery
Articles published between the years 2009 and 2023	Non-English language papers
	Articles published before the year 2009
	Systematic literature reviews

Source: Author's own work.

**Table 2.** SLR search results.

Search engine	Search string
Scopus	"Integrated Project Delivery" AND "Barriers" OR "Challenges" OR "Obstacles" published from 2009 to 2023
Emerald	"Integrated Project Delivery" AND "Challenges" published from 2009 to 2023
ScienceDirect	"Integrated Project Delivery" AND "Challenges" published from 2009 to 2023

Source: Author's own work.

shape IPD outcomes in NZ and, by adopting a systems perspective, help identify root causes and inform effective policies.

## Methodology

A systematic literature review (SLR) and eighteen semi-structured in-depth interviews (SSIs) were conducted with construction professionals in NZ to determine the interactions between factors affecting IPD, and the results are presented. The rationale for this study is that various articles have detailed the factors of IPD. However, the interactions between these factors remain a research gap. Thus, the objective of this research is to identify the key factors and their interrelationships affecting the implementation of IPD in NZ. Semi-structured interviews (SSI) were selected as the data collection method to facilitate exploration of the interactions among factors influencing IPD in NZ. The use of open-ended questions enabled interviewees to provide detailed, reflective responses, resulting in rich data. Figure 1 provides a flowchart overview of the data collection and analysis processes.

### Data collection

An SLR was conducted to identify all existing factors to IPD in the literature. Table 1 outlines the inclusion and exclusion criteria.

The search period was selected to coincide with the initiation of IPD in 2004, with the intention of building on existing reviews to reflect the field's maturity. Consequently, a five-year (from 2009) window was chosen to facilitate a comprehensive understanding of the IPD model among researchers and industry practitioners. Table 2 presents the search string.

Further, the PRISMA chart in Figure 2 details the SLR process.

The articles were read thoroughly to create a journal and identify the factors influencing IPD and their interactions. The identified factors were coded and grouped into themes. Then, the SLR results were used to frame the open-ended questions regarding themes, factors, and relationships. Subsequently, eighteen semi-structured interviews were conducted with construction-related professionals to identify the interactions between factors obtained from the SLR that affect the implementation of IPD in NZ. The interviewees were selected based on their experience in the construction sector and prior working experience with IPD. The interviewees were approached through their public profiles, followed by an email invitation. The hour-long interviews were conducted online and transcribed using the built-in transcription feature of the Microsoft Teams application. A purposive and snowball sampling methods were used to identify the interviewees. No new themes were identified after the fifteenth interview, and saturation was obtained after eighteen interviews. Table 3 details the profiles of the interviewees.

### Data analysis

Each interview transcript was read at least twice to identify factors and interactions. Through manual coding, the researcher identified the factors and their interactions affecting the implementation of IPD. The interactions were categorised as either positive (+) or negative (−), with (+) indicating that factor A increased factor B, and (−) indicating that factor A decreased factor B. This procedure was completed for each of the eighteen interviewees, with the results recorded in an Excel workbook and the network visualised using VENSIM. To ensure validation, the same protocol was followed for each interviewee. Interviews were conducted online using Microsoft Teams, recorded, and auto-transcribed. The research

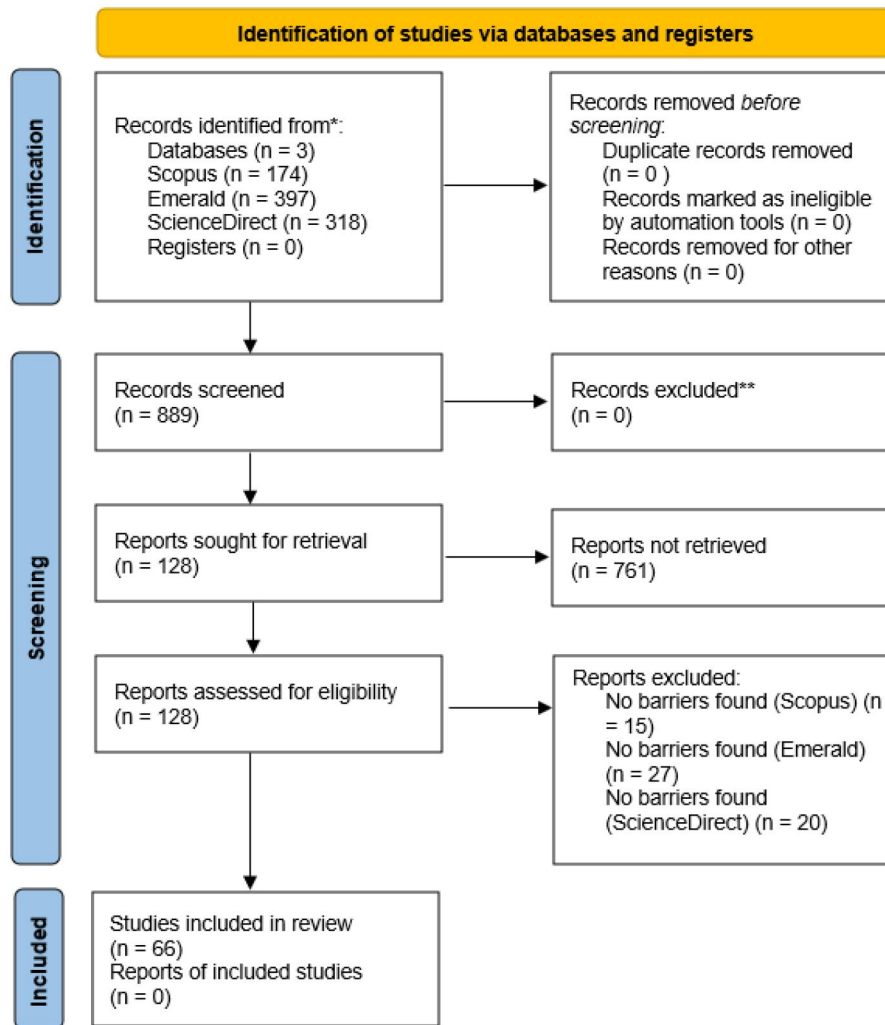


Figure 2. PRISMA chart for the SLR process. Source: Author's own work.

team reviewed the transcripts to ensure the accuracy and correctness of data extraction. Ensuring validation in research involves confirming that methods, instruments, and data accurately represent the concepts being studied. Sample transcription coding is shown below:

C2: 'I believe that it is relatively lowly implemented; the reason for that is because there is not a particularly good proven track record within the construction industry in New Zealand. And I think because of that, there is a reluctance from the likes of clients and or constructors or any stakeholder.'

Using deductive reasoning, it was concluded that contractors' lack of familiarity with the IPD approach (LoF) increases stakeholders' resistance to change (RtC). The next step was to assess the criticality of the factors based on network connections. For this purpose, this study utilised System Dynamics and Network Analysis methods. System Dynamics (SD), first revealed by Forrester (1961), is a methodology for

analysing the evolution of complex systems over time, driven by networks of causal relationships among their constituent elements (Ruiz *et al.* 2025). SD has been considerably used in the fields of construction management and energy to assess the impact of various policies and scenarios (Xu and Zou 2021). SD can be used for management strategies in construction projects (Iqbal *et al.* 2016), infrastructure planning policies (Castelblanco *et al.* 2024), and carbon emission policies in the construction sector (Eker *et al.* 2018). Causal loop diagrams (CLD) are a key tool in SD. CLDs constructively capture and visualise interactions in SD (Sterman 2000). CLDs offer a comprehensive perspective of SD by illustrating how alternative variables within a system are interconnected. CLDs consist of variables connected by arrows, where the variable at the tail represents the cause and the variable at the head represents the effect. The polarity of these arrows, whether positive (+) or negative (-), helps differentiate between direct and inverse relationships

**Table 3.** Interviewee profiles.

Interviewee code	Designation	Years of experience	Years of IPD experience	Organisation type and size	Sector focus
C1	Project Manager	20+	6+	Private, 500+	VC
C2	Building Services Engineer	30+	8+	Private, 12,000+	VC + HC
C3	Technical Director	30+	7+	Private, 5000+	VC + HC
C4	Technical Director	20+	5+	Public, 1600+	HC
C5	Lean Coordinator	10+	2+	Private, 5000+	VC + HC
C6	Construction Manager	10+	2+	Private, 1000+	VC
C7	Commercial Manager	30+	5+	Public, 1600+	HC
C8	Commercial Manager	25+	5+	Private, 5000+	VC + HC
C9	Construction Manager	10+	3+	Private, 900+	VC
C10	Quality Manager	25+	6+	Private, 5000+	VC + HC
C11	Project Delivery Manager	20+	5+	Public, 31000+	VC + HC
C12	Project Director	30+	8+	Private, 5000+	VC + HC
C13	BIM Coordinator	10+	3+	Private, 1000+	VC
C14	Quality Lead	10+	4+	Private, 1000+	VC + HC
C15	Project Manager	15+	5+	Public, 2000+	VC + HC
C16	Project Manager	20+	5+	Private, 4000+	VC + HC
C17	BIM Coordinator	10+	3+	Private, 4000+	VC + HC
C18	Project Planner	10+	2+	Private, 5000+	VC + HC

Source: Author's own work.

VC: vertical construction; HC: horizontal construction.

(Sterman 2000). SD through CLDs was deemed appropriate for modelling factor interactions due to the ease and clarity of data presentation. Network Analysis (NA) is a complementary method to SD (Schoenenberger and Schenker-Wicki 2014).

NA was first identified in 1932, where a social network was mapped using “sociometry”, a technique for eliciting and graphically representing individuals’ subjective feelings toward one another (Borgatti *et al.* 2009). The theory of networks facilitates the development of explanations in a wide range of disciplines, including psychology, economics, and management consulting. A key task of NA has been to invent graph-theoretic properties that characterise structures, positions, dyadic properties, and the overall shape of ties. At the node level of analysis, the most widely studied concept is centrality: a family of node-level properties relating to the structural importance or prominence of a node in the network (Borgatti *et al.* 2009). Schoenenberger and Schenker-Wicki (2014) believe that the centrality measures used in NA are a valuable complement to the analysis techniques employed in SD, as they can serve as a first screening tool for large SD models to identify potential levers within the model. To understand the criticality of factors based on connections within the network, three analysis methods—Degree of Centrality (DC), Eigenvector Centrality (EC), and Causal Chain Analysis (CCA)—were employed to identify the critical factors in the network. In NA, centrality is a frequently used method to determine which vertex holds a critical position in a network (Laghradat and Essalih 2023). Centrality measures answer the question “who is the most important vertex in the network?” The answer to

this question depends on the power that a vertex has in terms of the number of direct and indirect connections. The study of centrality determines the role of a vertex within a network, as well as its influence on the flow and sharing of information (Rochat 2009). DC is one of the most commonly used centrality measurements in network analysis as it aids in measuring the activity of transfer and communication within a network (Freeman 1978). DC is a suitable centrality measurement to indicate the influence of individual vertices within a network (Lee *et al.* 2010). DC is a local centrality calculated from a node’s immediate neighbourhood links (Bamakan *et al.* 2019). It is the most straightforward centrality measure to compute, and the DC for a node is its degree (Golbeck 2015). Typically, the numbers are converted to a 0–1 scale, and the node with the highest number of links in the network has a DC of 1. The centrality of other nodes will be a fraction of their degree compared to that of the most popular node. DC was deemed a suitable analysis method due to its straightforward computation and relevance. EC goes beyond DC to identify the importance of each node within a network (Agrzkov *et al.* 2017).

EC measures a node’s significance by considering its neighbours’ significance (Golbeck 2013). EC suggests a node is more central as it is connected to important nodes (Bonacich 2007). Using the power iteration method, each node in the network is assigned a value; the higher the value, the greater the node’s influence within the network (Meghanathan 2015). EC suggests that links from important nodes are worth more than those from unimportant nodes. In the beginning, all nodes start equal, but nodes with more edges gain importance as the calculation

progresses based on the significance of the nodes to which they are linked. A node will have a higher score if it is connected to high-valued nodes than if it has equal connections to low-valued nodes. This research followed Meghanathan (2015) in calculating the EC. All factors to IPD were arranged in a matrix based on their incoming nodes to compute the EC. The matrix was multiplied by a column vector of unit 1, and the total incoming nodes of each factor were listed (Meghanathan 2015). Then, the normalised value was calculated (the square root of the sum of squares of node values). The node value of each factor was divided by the normalised value, resulting in the eigenvalue of each factor. The iterations were repeated until the normalised value stabilised (Meghanathan 2015). After eight iterations, the normalised value stabilised, and the final eigenvalues of each factor were noted. EC is a suitable measure of network centrality (Bonacich 1972), as it accounts for the entire network pattern (Bonacich 2007). Additionally, Bihari and Pandia (2015) think that EC is more suitable than other centrality measures for identifying the most prominent vertex in a network. Moreover, Agryzkov *et al.* (2017) believe that EC is the most suitable centrality measure for identifying the most and least influential vertices in a network. EC was deemed a suitable analysis method because it helps identify the most critical vertex in a network. The interactions between the factors can be studied in more detail using CCA, and the sum of the DC and EC values for the factors can help identify the heaviest chains, which are deemed critical.

CCA involves developing a logic model and using it to anchor subsequent analysis, aiming to provide empirical evidence for parts of the causal chain and information about contextual modifiers (Kneale *et al.* 2018). CCA maps essential linking elements, usually at the business-unit level of analysis (Cascio and Boudreau 2008). CCA describes an approach that utilises various methods to theorise and test how interventions influence outcomes. Logic models are graphical representations of programme theory that depict intervention components, mechanisms, outputs, and outcomes as a sequential chain of events—these form the basis of CCA (Kneale *et al.* 2018). CCA was deemed appropriate for identifying the critical chains of factors that impact the implementation of IPD in NZ, as it provides a comprehensive understanding of the factor interactions. The VENSIM model was used as the logic model and analysed to identify possible causal chains that impact IPD implementation in NZ. The results and discussions are presented next.

## Results

The SLR identified 127 factors from 66 articles grouped under six themes, which were then used to frame the open-ended questions for the SSI. Table 4 details the individual factors of IPD using theme, SLR frequency (the number of times a factor has been mentioned by an author in the literature), SSI frequency (the number of times NZ construction professionals have mentioned a factor), DC, and EC.

Figure 3 visualises all interactions revealed by the interviewees using VENSIM. The blue arrows indicate a positive influence, that is, factor A causes factor B to increase, while red arrows indicate a negative influence, that is, factor A causes factor B to decrease.

Lack of factual information about IPD, Limited number of contractors and consultants, Federal *versus* local council model policy and governance conflicts, Industry opting for traditional models, Experienced professionals' mindset, History of liquidation of contractors resisting risks, Subcontractors taking main contractor roles, and Project size were newly identified factors discovered during the SSI process. They were not identified in the prior SLR and can be considered NZ-specific factors that aid in understanding the impact of the identified critical factors and interactions in the NZ context. Table 5 compares the top 10 factors from the DC, EC, and frequency analyses. The SLR identified global IPD factors, while the SSI frequency analysis and centrality analyses revealed factors specific to NZ.

Resistance to change, mutual respect and trust, high initial investment, and the lack of technology use have been identified as the critical factors, as they consistently ranked among the top factors across all analyses. Additionally, even though the client's resistance to change and lack of industry standardisation did not appear among the top factors in the frequency analysis, they should be considered critical in the NZ context. Additionally, a total of 139 interactions were identified; the most frequently mentioned (3 or more) were shortlisted. Table 6 presents the shortlisted interactions.

Moreover, the interactions were further studied using CCA. 45 chains were identified; however, the most critical ones—the longest and heaviest (DC and EC)—were shortlisted. Table 7 presents the analysis of the shortlisted critical chains by chain length, weight, DC weight, and EC weight.

## Discussion

The comparison of DC, EC, SSI, and SLR (see Table 5) revealed the factors affecting IPD implementation in

**Table 4.** IPD Factors are listed as per various analyses.

Factors	Theme	SLR frequency	SSI frequency	DC	EC
Lack of collaboration among construction stakeholders (LoC)	CC	15	15	0.52	0.0545
Lack of integration of key stakeholders (LoI)	CC	7	11	0.21	0.024
Lack of transparency (LoT)	CC	2	4	0.13	0.0348
Self-protective approach (SPA)	CC	6	10	0.34	0
Poor transmission through all phases of the project (PTP)	CC	1	0	0	0
Mutual respect & trust (MR&T)	CC	10	11	0.56	0.244
Achieving actual joint project control (AAJPC)	CC	2	6	0.26	0.024
Challenging cultural paradigms (CCP)	CO	17	7	0.34	0.0555
Lack of IPD awareness/knowledge among stakeholders (LoA)	CO	18	15	0.60	0.0655
Resistance to change among stakeholders (RtC)	CO	9	12	1	0.434
Inherent difficulties in changing organisational culture (IDCOC)	CO	7	1	0.04	0
Client's/owner's resistance to change (CRtC)	CO	6	11	0.69	0.449
Awareness and willingness about IPD among owners (AaW)	CO	4	1	0.08	0.273
Early contractor involvement (ECI)	CO	4	0	0	0
Interoperability (I)	CO	4	0	0	0
Participation (P)	CO	2	0	0	0
Lack of partnering as a tool for achieving lean construction performance (LoPtLC)	CO	1	0	0	0
Owner not identifying advantages (ONIA)	CO	2	1	0.04	0
Lack of effective information sharing (LoEI)	CO	1	2	0.13	0
Lack of responsive decision-making regimes (LoRDM)	CO	1	0	0	0
Lack of coordination in managing the project (LoCo)	CO	2	2	0.08	0.0536
Future orientation (FO)	CO	3	0	0	0
Integration of information and knowledge management systems (IIKMS)	CO	3	0	0	0
Inculcating the values of IPD (IVIPD)	CO	2	3	0.13	0.0825
Lack of promotion of IPD (LoP)	CO	2	6	0.34	0.139
Assigning project leadership (APL)	CO	1	0	0	0
Attitude-related barriers (ARB)	CO	1	0	0	0
Business risk (BR)	CO	1	1	0.04	0
Difficulties in converting strategic decisions to operational levels (DiC)	CO	1	2	0.17	0.0555
Inefficiency in resource planning (IiR)	CO	1	2	0.04	0
Industry participants lack chances to receive IPD-related training (IPLC)	CO	3	3	0.08	0
Lack of leadership and uncertainty of risk involved (LoL)	CO	1	1	0.04	0
Lack of trained professionals (LoTP)	CO	3	3	0.13	0
Lack of existing training material (LoETM)	CO	5	4	0.13	0.118
Lack of organisational communication (LOCm)	CO	2	1	0.04	0
Lack of owner involvement (LoOI)	CO	2	0	0	0
Lack of constraint analysis and planning process (LoCA)	CO	1	4	0.17	0
Lack of proficiency and strong management of the employer (LoPr)	CO	3	2	0.08	0
Lack of familiarity of contractors with the IPD approach (LoF)	CO	1	6	0.26	0.124
Lack of a standard way to measure the degree of design integration (LoSW)	CO	1	0	0	0
Lack of a standard way to measure the whole life cycle project quality (LoSWW)	CO	1	0	0	0
Lack of proper definition of responsibilities of each party to the contract (LoPDR)	CO	1	0	0	0
Lack of proper definition of the culture of teamwork among project key stakeholders (LoPDC)	CO	1	0	0	0
Lack of sufficient knowledge about design, construction, and maintenance among representatives of the employer (LoSK)	CO	1	1	0.04	0
Lack of experience and skills (LoES)	CO	4	5	0.21	0
Lack of interest to upgrade (LoIU)	CO	4	6	0.26	0.0655
Lack of lean knowledge (LoLean)	CO	2	4	0.17	0
Logistical challenges (LC)	CO	1	2	0.08	0
Mindset of individuals (Moi)	CO	2	1	0.04	0
Partner selection (PS)	CO	1	0	0	0
Poor data transfer among different phases of a project (PDT)	CO	1	1	0.04	0
Project objectives-related barriers (PORB)	CO	1	4	0.17	0
Signing of participants' task scope (SoPTS)	CO	1	0	0	0
Setting of incentive plans (SolP)	CO	1	0	0	0

*(continued)*

Table 4. Continued.

Factors	Theme	SLR frequency	SSI frequency	DC	EC
Structure for facilitation (Sff)	CO	1	1	0.04	0
The effect of a weak matrix structure (TEWM)	CO	1	1	0.04	0
Unclear responsibilities of the parties (UR)	CO	3	1	0.04	0
Different criteria for services procurement (DCfSP)	CO	2	0	0	0
Early definition of target goals without a fully developed design (EDTG)	CO	1	1	0.04	0
Project management difficulties (PM)	CO	1	1	0.13	0.0251
Risk allocation mechanism (RAM)	CO	2	1	0.04	0.0297
Subjectivity in measuring quality (SIMQ)	CO	1	0	0	0
Work processes (WP)	CO	1	0	0	0
Developing high-quality design (DHQD)	CO	3	1	0.04	0
Lack of industry-wide standardisation (LoIW)	CO	1	7	0.47	0.29
Lack of experience in new roles (LoENR)	CO	1	2	0.04	0
Making sound and timely decisions (MSTD)	CO	2	1	0.04	0
New approach takes time (NATT)	CO	3	0	0	0
Selecting the right team (StRT)	CO	1	0	0	0
Understanding the cross-functional organisational approach (UtCFOA)	CO	1	0	0	0
Lack of factual information about outcomes from IPD in NZ (LoFI)	CO	0	1	0	0
Limited number of contractors and consultants (LCC)	CO	0	1	0	0
Institutional inertia (II)	CO	1	0	0	0
Industry opting for traditional models (IoTM)	CO	0	1	0	0
Experienced professionals' mindset (EPM)	CO	0	1	0	0
History of liquidation of contractors resisting risks (HLC)	CO	0	1	0	0
Subcontractors taking main contractor roles (StMCR)	CO	0	1	0	0
Project size (PsZ)	CO	0	1	0	0
High initial investment (HII)	F	16	7	0.3	0.187
Profit pooling—paying profits after all project works are completed (PP)	F	1	0	0	0
Insurance products designed for IPD are not widely available (IPfIPDNA)	F	3	0	0	0
Lack of fair IPD compensation models (LoFIPDCM)	F	3	3	0.13	0
Compensation structure (CS)	F	5	3	0.17	0
Hard pricing (HP)	F	1	1	0.04	0
Seeking the lowest cost (SfLC)	F	1	3	0.13	0
Inventory cost (IC)	F	1	0	0	0
Lack of an accurate cost estimation methodology (LoACE)	F	1	0	0	0
Lack of coordination for the compensator for F losses (LoCCFL)	F	1	0	0	0
Lack of a standard way to ascertain the credit rating/worthiness of a company (LoSECR)	F	1	0	0	0
Misunderstandings in risk contingency accounting (MIR)	F	2	1	0.04	0
The high F cost of new software and equipment (HFCNS)	F	3	4	0.13	0
The client needs to pay for the additional cost of drafting a new agreement for IPD (TCPACNA)	F	1	1	0.04	0
The client needs to pay additional design fees due to time and material-based compensation (TCPAFM)	F	1	2	0.08	0
Cost estimation challenges (CEC)	F	5	4	0.13	0.176
Reward not tailored to reflect the stochastic nature of the risks involved (RnTRSR)	F	4	3	0.08	0
Difficulties in achieving F transparency (DiA)	F	2	0	0	0
Relative capital investment (RCI)	F	1	0	0	0
Lack of transparency in spending done by the contractor (LoTSC)	F	1	1	0.04	0
Lack of governmental support (LoGS)	GP	8	11	0.65	0.116
Lack of professional bodies (LoPB)	GP	1	5	0.13	0.187
Contractual L aspects (CLA)	L	27	13	0.39	0
Lack of insurance policies and bonding arrangements (LoIP)	L	6	3	0.13	0.0866
Lack of existence of similar IPD contracts (LoESIPD)	L	4	3	0.08	0.0655
Lack of legislative regulations (LoLR)	L	1	0	0	0
A requirement of the new L framework (ARnLF)	L	2	0	0	0
Data sharing (contractual) (DS)	L	1	0	0	0
Dispute resolution (contractual) (DR)	L	1	0	0	0
Liabilities and indemnification (contractual) (L&I)	L	4	0	0	0
Risks and incentives (contractual) (R&I)	L	1	3	0.08	0
Selection of compensation and incentive structure (SoCIS)	L	2	1	0.04	0
Suspension and termination (contractual) (S&T)	L	1	0	0	0
Application of IPD principles with no standard contract agreement (AIPDNC)	L	1	0	0	0
	L	2	0	0	0

(continued)

Table 4. Continued.

Factors	Theme	SLR frequency	SSI frequency	DC	EC
Lack of suitable liability waivers between stakeholders (LoSLW)					
Expert contract administrators (ECA)	L	2	0	0	0
Implementation of strict rules, policies, and regulations (IoSR)	L	2	3	0.13	0
Contract signing (CSi)	L	2	0	0	0
Deciding framework for contractual renegotiations (DRCR)	L	1	0	0	0
Inappropriate contractual strategies (ICS)	L	1	0	0	0
Non-availability of suitable IPD contracts (NSIPD)	L	2	1	0.04	0.0655
The tendency to use conventional contractual methods and resistance against new ideas (TCCRN)	L	1	0	0	0
Unclear contract terms and objectives (UCTO)	L	1	0	0	0
Uncertainty of risk involved in multiparty contracts (URMPC)	L	1	0	0	0
Current construction rules and regulations (CCRL)	L	4	1	0.04	0
Differences in contracting methodology (DiCM)	L	1	0	0	0
IPD contract types are not tested or understood (IPDNTU)	L	1	0	0	0
Lack of governmental incentives, policies, regulations, or L frameworks (LoGipr)	L	3	5	0.04	0.0532
No dispute resolution clause (NDR)	L	1	0	0	0
Signing a contract with no hierarchical structure (IPD's organisational structure) (SCNHS)	L	1	0	0	0
Federal <i>versus</i> local council model policy and governance conflicts (FvLCM)	L	0	2	0	0
Lack of usage of technological advancements (ex., BIM) (LoUT)	T	24	11	0.52	0.385
Availability of adequate Information Technology (IT) infrastructure (AoAIT)	T	5	0	0	0
Governmental payment procedure, which entails T advancement (GPT)	T	1	0	0	0
Industry participants' IT skills are insufficient (IPIT)	T	1	1	0.04	0
Lack of Information and Communication Technology usage (LoICT)	T	2	1	0.04	0
BIM and IPD integration challenges (B&IC)	T	2	7	0.08	0.176

Source: Author's own work.

NZ (RQ1). Resistance to change, mutual respect and trust, high initial investment, lack of technology use, lack of industry standardisation, and clients' resistance to change are the critical factors identified across all analyses.

### **Resistance to change (SLR rank = 9, SSI rank = 3, DC rank = 1, EC rank = 2)**

Jadidoleslami *et al.* (2019) defined resistance to change as the need to move away from traditional management towards modern management, particularly by fostering integration within management. Resistance to change can come from the project stakeholders or the client. Nonetheless, the tendency to use traditional contracts causes resistance to new ideas (O'Connor 2009). Rached *et al.* (2014) think that organisations and people are resistant to new ideas. Porwal and Hewage (2013) believe that one of the significant challenges to IPD is resistance to change. Abanda *et al.* (2015), Olawumi *et al.* (2018), and Evans and Farrell (2020) each found that resistance to change from conventional construction practices is a significant factor in implementing IPD. The resistance to change among construction stakeholders is a key

barrier to implementing innovative project delivery models, such as IPD. Resistance to change has negatively impacted the skills, knowledge, and experience of project stakeholders in the construction industry. Hence, for the construction industry to experience increased implementation of the IPD model, a significant change in stakeholders' attitudes and perceptions is warranted (Evans *et al.* 2020).

Additionally, Ma *et al.* (2022) believe that the changes from traditional project delivery methods to IPD may create barriers due to resistance from diverse areas. However, some of these components and changes have been implemented by industry practitioners with integration experience from previous projects. Although adopting IPD may require changes that create barriers to implementation, practitioners' perceptions of these barriers may vary depending on the degree of integration experience they have accumulated (Ma *et al.* 2022). Sherif and Abotaleb (2022) mentioned the concept of personal resistance to change, that is, stakeholders depend on the types of contracts they trust and are reluctant to change. Bhone *et al.* (2020) noted that resistance to change can stem from greater involvement in project management, while Boodai (2014) believed it can originate from cultural



Table 5. Comparison of top factors to IPD based on various analyses.

Factor	DC	DC rank	Factor	EC	EC rank	Factor	SSI- F	SSI- F rank	Factor	SLR- F	SLR- F rank
Resistance to change	1	1	Client's resistance to change	0.449	1	Lack of collaboration	15	1	Contractual legal aspects	27	1
Client's resistance to change	0.69	2	Resistance to change	0.434	2	Lack of IPD awareness	15	1	Lack of technology use	24	2
Lack of governmental support	0.65	3	Lack of technology use	0.385	3	Contractual legal aspects	13	2	Lack of IPD awareness	18	3
Lack of IPD awareness	0.6	4	Lack of industry standardisation	0.29	4	Resistance to change	12	3	Challenging cultural paradigms	17	4
Mutual respect & trust	0.56	5	Awareness and willingness among owners	0.273	5	Lack of integration	11	4	High initial investment	16	5
Lack of collaboration	0.52	6	Mutual respect & trust	0.244	6	Mutual respect & trust	11	4	Lack of collaboration	15	6
Lack of technology use	0.52	6	High initial investment	0.187	7	Client's resistance to change	11	4	Mutual respect & trust	10	7
Lack of industry standardisation	0.47	7	Lack of professional bodies	0.187	7	Lack of Governmental support	11	4	Resistance to change	9	8
Contractual legal aspects	0.39	8	BIM and IPD integration challenges	0.176	8	Lack of technology use	11	4	Lack of Governmental support	8	9
Challenging cultural paradigms	0.34	9	Cost Estimation Challenges	0.176	8	Lack of industry standardisation	7	5	Lack of integration	7	10
Self-protective approach	0.34	9	Lack of IPD promotion	0.139	9	Challenging cultural paradigms	7	5	Inherent difficulties in changing organisational culture	7	10
Lack of IPD promotion	0.34	9	Lack of familiarity of contractors with IPD	0.124	10	High initial investment	7	5			
High initial investment	0.30	10	BIM and IPD integration challenges				7	5			

Source: Author's own work.  
F: frequency.

confident in partners' capabilities to complete a project. Competence and trust are essential for joint decision-making (Zhang *et al.* 2018). Pishdad-Bozorgi and Beliveau (2016) believe that the lack of mutual trust among project stakeholders regarding financial and management issues leads to increased changes, disputes, and claims, resulting in additional project costs.

### High initial investment (SLR rank = 5, SSI rank = 5, DC rank = 10, EC rank = 7)

The high initial investment can refer to costs associated with project initiation or the high costs of technology use (Evans and Farrell 2020). Dalui *et al.* (2021) found that IPD models often entail higher upfront costs for the owner during the consent and pre-construction phases, making it difficult for experts and project stakeholders to adapt to this novel approach. Regarding IPD, the industry needs to invest additional time and resources, particularly in utilising new contract forms and intensifying design (Cheng and Johnson 2016). Usually, stakeholders resist IPD as the return on investment is not guaranteed (Durdyev *et al.* 2019). Ebekozi *et al.* (2023) detailed financial issues, including problems with the compensation structure, weak background structure, inadequate coordination and training, high software costs, and the inability to structure how rewards and risks are shared. They further revealed that the solutions to these issues include establishing accountabilities, expectations, roles, and responsibilities for stakeholders, fostering teamwork to increase mutual compensation and incentives, and sharing targets, profits, and costs among stakeholders.

Additionally, Hettiaarachchige *et al.* (2022) identified high initial investment, compensation structure, inventory costs, currency fluctuations, and the high cost of new software and equipment as financial barriers to IPD implementation.

### Lack of technology use (SLR rank = 2, SSI rank = 4, DC rank = 6, EC rank = 3)

Several organisations and bodies have recognised the effective implementation of IPD through technology (AIA 2007, NASFA *et al.* 2010, AIA and AGC 2011). However, the lack of technology use is a critical factor in IPD. Kent and Becerik-Gerber (2010) identified that the industry's use of technology and BIM is not advanced enough to support IPD. Evans and Farrell (2020) confirmed the findings, revealing that current technology use is unsatisfactory. Eastman *et al.* (2011) believe that there is no extensive BIM-based cost

management platform that can perform all cost-related procedures. The combination of BIM and IPD enables a level of collaboration that enhances productivity and minimises errors, while also allowing the exploration of new, innovative concepts (Khanna *et al.* 2021). Porwal and Hewage (2013) revealed that IPD may be most effective in facilitating the use of BIM in construction projects. Moreover, IPD with BIM and ICT enhances the utilisation of technology while transforming the entire design and construction process. Also, professional leaders in the AEC industry are getting more aware of the potential of integrating emerging digital technologies such as cloud computing, BIM, blockchain, and mixed realities with tried-and-true workflow procedures, resulting in notable productivity gains and reductions in RFIs, field disputes, waste, and project timelines (Khanna *et al.* 2021). However, Ahmed and Sobuz (2020) found that two key roadblocks to the widespread adoption of IPD in developing countries are the lack of standardised BIM contract agreements and problems with using BIM as a collaborative framework.

#### ***Client's resistance to change (SSI rank = 4, DC rank = 2, EC rank = 1)***

In IPD projects, the owner diligently and continuously participates throughout the project to identify the value and prioritise the alternatives. The owner is, in fact, an essential contributor, rather than simply a service buyer (Cheng and Johnson 2016). The client's resistance to change makes IPD implementation unlikely, particularly in the NZ context, given its highest EC value. Risk will never be shared among the project stakeholders without the client's willingness. In IPD, the client is a key factor in ensuring project success (Li and Ma 2017). Govender *et al.* (2018) identified clients' failure to see the advantages of IPD as a significant barrier to its implementation. Karasu *et al.* (2023) also concluded that clients and owners play a key role in transitioning to a more collaborative approach.

Additionally, without the owner's willingness, risk will not be shared among the project parties. In the IPD context, the involved owner is a key factor in determining project success. Moreover, the owner decides on the project delivery model to be used, payment options, and selection of the project parties. Therefore, if the owner does not want to implement IPD, little can be done. Improving the level of awareness of the potential benefits of IPD adoption may increase owners' willingness, which can be achieved

through continuous professional development programs conducted by professional bodies in the built environment (Li and Ma 2017).

#### ***Lack of industry standardisation (SSI rank = 5, DC rank = 7, EC rank = 4)***

The construction industry is traditionally conservative and largely risk-averse, with recognised project delivery models and contractual frameworks that may not be easily adapted to the collaborative nature of IPD (Agupugo 2023). The lack of industry standardisation is a significant factor in the NZ context, even though it wasn't among the critical factors in the SLR results. Kent and Gerber (2010) emphasised the importance of BIM adoption for successful IPD adoption. They revealed that the absence of standard BIM contract documents and issues arising from the use of BIM as a collaborative framework are two major factors in IPD implementation. Additionally, Kraatz *et al.* (2014) also identified the lack of industry standardisation as a factor in IPD implementation. As the construction industry continues to face increasing pressure to enhance safety, reduce costs, and meet environmental and regulatory requirements, the adoption of IPD could play a critical role in achieving these objectives (Akpe *et al.* 2024). Successful implementation of IPD in the construction industry requires a strategic approach, including establishing clear contractual frameworks, fostering a culture of collaboration, investing in training, promoting technology adoption, encouraging early stakeholder involvement, and aligning IPD with project-specific goals and industry standards (Ekechukwu and Simpa 2024). Akpe *et al.* (2024) emphasised the establishment of clear contractual frameworks that meet IPD objectives. They further indicated that this can be achieved by developing agreements that outline shared goals, integrate decision-making processes, and establish mechanisms for resolving conflicts.

The experts through the SSI noted multiple interactions between the factors identified in the SLR that impact IPD implementation in NZ (RQ 2). A total of 139 interactions were identified; the most frequent interactions (mentioned by 3 or more interviewees) were deemed critical and are listed in Table 6. Based on the most frequently mentioned interactions, lack of collaboration, lack of integration, lack of IPD awareness, contractual legal aspects, BIM and IPD challenges, lack of governmental support, lack of governmental incentives and policies, lack of professional bodies, self-protective approach, high financial cost of new software, and achieving actual joint project control are deemed

**Table 6.** Most frequent interactions revealed by interviewees.

Factor A	Factor B	Polarity	Identified by no. of interviewees
Lack of collaboration	Lack of integration	+	10
Lack of IPD awareness	Lack of collaboration	+	9
Lack of IPD awareness	<b>Resistance to change</b>	+	7
Contractual legal aspects	<b>Mutual respect &amp; trust</b>	–	6
<b>Lack of technology use</b>	BIM and IPD integration challenges	+	6
Lack of governmental support	Lack of governmental incentives and policies	+	5
Lack of governmental support	Lack of professional bodies	+	4
<b>High initial investment</b>	<b>Resistance to change</b>	+	4
Self-protective approach	<b>Mutual respect &amp; trust</b>	–	4
Lack of IPD awareness	<b>Client's resistance to change</b>	+	4
Contractual legal aspects	<b>Resistance to change</b>	+	3
High financial cost of new software	<b>Lack of technology use</b>	+	3
Lack of governmental support	<b>Mutual respect &amp; trust</b>	–	3
Self-protective approach	Achieving actual joint project control	–	3
<b>Lack of industry standardisation</b>	<b>Resistance to change</b>	+	3

Source: Author's own work.

critical factors. Two of the 15 identified interactions were also mentioned in the SLR.

### **The lack of IPD awareness increases resistance to change among stakeholders**

It is known that IPD implementation is not widespread in many countries, though it is prevalent in some regions, such as North America and the UK. As such, industry practitioners worldwide will resist its adoption if they are not familiar with the IPD model (Charlesraj and Gupta 2019, Hettiaarachchige *et al.* 2022). Interviewee C7 quotes, "If people don't understand the extent of that change and they're not willing to implement the processes, systems, or organisational changes that need to come, then I think you will find resistance to change."

### **Contractual legal aspects reduce mutual respect and trust among stakeholders**

The IPD model is unique for its complex legal structure; as such, this is likely to create trust issues among industry participants worldwide (Naismith *et al.* 2016, Li and Ma 2017). Interviewee C11 quotes, "The only mistrust is normally caused from sort of commercial arrangements, and variation works that I've experienced."

Table 6 shows 13 more interactions that were not identified in the SLR but were identified by experts as prominent in the NZ context. These can be deemed critical to IPD implementation challenges in NZ, and they may be applicable to other countries and regions:

### **Lack of collaboration increases the lack of integration between stakeholders**

The NZ construction industry suffers from collaboration and fragmentation issues. Interviewee C1 quotes,

"Yeah, I think collaboration is key to IPD. It's the very essence of it in terms of the current industry, I see some very mixed levels of collaboration." For successful IPD implementation, the project parties must have a high level of integration among themselves. Given the already low levels of collaboration in the NZ construction sector, it is not difficult to understand why IPD is poorly implemented in NZ. The core philosophy of an IPD contract revolves around collaboration, and if this issue is not addressed, IPD implementation in NZ is unlikely.

### **Lack of IPD awareness increases the lack of collaboration between stakeholders**

IPD is unheard of in NZ, and although Alliancing, a collaborative project delivery method popular in NZ, also revolves around collaboration, it is only prevalent in large public-sector projects. The wider NZ construction sector still follows the traditional project delivery approach, where collaboration issues are on the rise. Interviewee C5 quotes, "But if people would understand the IPD concept better, they would probably be more collaborative, yeah." This interaction may suggest that the interviewees believe increased awareness of other collaborative project delivery models, such as IPD, may enhance collaboration across the wider NZ construction sector.

### **Lack of technology use increases challenges with BIM and IPD integration**

The NZ construction industry lags in adopting technology. The current BIM usage is comparable to that in San Francisco 20 years ago, as interviewee C1 mentioned. The impact of the lack of technology use is clear: NZ is trailing other developed countries in its

use of technology. Further interviewee C4 quotes, “BIM is immature and it’s I guess at the very start of its journey about how it influences design coordination and then the ongoing maintenance and operation of an asset in New Zealand.”

### ***Lack of governmental support increases the lack of governmental policies for IPD***

The NZ government supports collaborative contracting, as evidenced by the adoption of the Alliancing project delivery method for large public-sector projects. However, the IPD model remains unheard of in the country. The legally structured approach to risk sharing in the IPD model is deemed risky by contractors; additionally, the mandated use of technology, such as BIM, creates additional hurdles, as BIM use is less common in NZ than in North America and the UK. For these reasons, the NZ government may not adopt the IPD model. Interviewee C6 quotes, “I don’t really see the government driving any change within the industry. I don’t see a huge amount of support being put in place by the government in terms of IPD.” The lack of support for the IPD model suggests that the NZ government is unlikely to implement policies and regulations to support it. There is no policy, regulation, or incentive in favour of the IPD model. This differs from the Singaporean context, where the government has promoted the IPD model by issuing a procurement guide for early contractor involvement. Singapore’s Building and Construction Authority restricts the number of tenderers to five and provides guidelines for the evaluation of tenders (Ma *et al.* 2022).

### ***Lack of governmental support increases the lack of professional bodies for IPD***

The contractual issues with the IPD model, along with the mandated use of technology that is not favourable to the current NZ construction industry, are reasons why the NZ government is unlikely to support IPD implementation in its projects. The lack of governmental support suggests the NZ government is unlikely to support the establishment of professional bodies relevant to IPD in the country. Interviewee C1 quoted, “It’s probably been a little bit soft on from the government as a leading client that they could have been pushing that, they would be looking at some form of mandatory implementation on projects.” Further, interviewee C7 quoted, “I think there’s a real lack of presence of those professional bodies.” While Canada has the

Integrated Project Delivery Alliance (IPDA) to oversee and raise awareness of the delivery model in the region (Arar *et al.* 2025), there is no professional body established in NZ. This is unlikely if the NZ government does not support its implementation in the country.

### ***The high initial investment requirement of IPD increases resistance from stakeholders***

The history of contractor liquidations in NZ has led contractors to exercise caution, and thus, the high investment required for IPD is deemed risky, which has led to resistance. Interviewee C2 quotes, “Yeah, yeah, I do. I do think that financial decisions can impede the participation of IPD processors. So stakeholders, especially financial ones, do shy away from suggesting an IPD approach.” This differs across countries and regions, where there is a much larger population of Tier 1 contractors, and contractor liquidations are not on the rise.

### ***The self-protective approach decreases mutual respect and trust among stakeholders***

Interviewee C14 believes that stakeholders’ self-protective approach reduces trust among them, which is required for IPD implementation. They quote, “Individual interest does lower the trust among various participants.” This differs from regions and countries where IPD is well-established, such as North America, leading to less caution among stakeholders.

### ***The self-protective approach of stakeholders decreases the required joint project control***

The complex legal structure of the IPD model prompts caution among project participants, leading to a self-protective approach. On the contrary, the IPD model itself necessitates joint project control, which can only be achieved through open communication and collaboration. Interviewee C18 quotes, “I believe everyone would seek their own part of the project. So basically my assumption would be that no people wouldn’t engage in a project if they are not taking their part.” The lack of collaboration and open communication is a significant issue in the current NZ construction industry; thus, this interaction reveals why IPD uptake is unlikely in NZ at present. This also differs from regions and countries where IPD is well-established, such as the UK.

### **The lack of IPD awareness increases the client's resistance**

While clients in North America and the UK may be aware of the IPD model, those in NZ are not. Interviewee C17 quotes, "It has to come down from the client side, the key stakeholders on the project basically, but they might not be knowledgeable enough to understand all the technicalities."

### **Contractual legal aspects increase resistance from stakeholders**

This interaction is particularly prominent in NZ and other Middle Eastern countries. The problem revolves around the risk assignment factor, where the absence of a legalised framework makes IPD implementation unlikely (Sherif *et al.* 2022). Interviewee C1 quotes, "So I see New Zealand as sort of 15 to 20 years behind. The cutting edge in other countries, and I think yeah, people have from my experience, subcontractors and contractors have been very hesitant to get on board with new ways of doing things. Yeah, I'm not sure how New Zealand would handle a true IPD contract." This differs from countries such as the USA, Canada, and Singapore, where IPD frameworks are in practice. The USA has the ConsensusDocs 300 (Ahmed *et al.* 2021), along with other agreements, to facilitate the IPD model, while Canada has the CCDC 30 contract to facilitate the IPD model (Arar *et al.* 2025), and Singapore has the NEC4 Engineering and Construction Contract to promote collaborative project delivery models (Ma *et al.* 2022).

### **High financial cost of new software increases the lack of technology use**

The NZ construction sector underuses technology. Interviewee C8 believes the high financial cost of new technologies is a reason for their underuse. C8 quoted, "You know, at the end of the day, yeah, you could say that they expect all the technological advances and things like that, but they don't necessarily want to pay for them if they're actually costing more." This differs from countries that are actively using the latest technology in their projects, such as North America and the UK.

### **Lack of governmental support decreases mutual respect and trust among stakeholders**

The NZ government has not shown support for the IPD model. Interviewee C7 believes that, in the

absence of governmental support, industry stakeholders lose trust in one another. They quote, "If the intentions of the government are not manifest in the contract and they are clearly something else, that creates mistrust amongst the parties." This differs from the Singaporean context, where the government promotes collaborative contracting (Ma *et al.* 2022).

### **The lack of industry standardisation increases resistance from stakeholders**

The lack of factual data on IPD in NZ suggests that its implementation in the private sector is unlikely. Interviewee C8 quotes, "I think that it still is a challenge in certain areas and I would suspect that is because people and organizations haven't taken that initial leap of faith to give it a go and embrace it." Given the issues facing the NZ construction sector, especially the history of contractor liquidations, private construction firms would deem its implementation too risky. This interaction differs from other regions and countries where IPD has been established, such as North America and the UK.

Figure 3 shows the interactions among the factors derived from SSI. The analysis of Figure 3 revealed multiple chains, which were ranked using chain weight (see Table 7). The chain weight was calculated based on the polarity of the factors in the chain; for example, a positive relationship received a score of (+1), while a negative relationship received a score of (−1). Similarly, the chain DC and EC weights were calculated by substituting the factor value instead of (±1).

The longest chain begins with the client needing to pay extra design fees, indicating that the additional design fees paid by the client due to time-and-materials-based compensation are the root cause of the problem, as they create complications with contractual legal aspects, leading to the self-protective approach taken by stakeholders. This leads to a lack of collaboration and integration among stakeholders, resulting in a lack of interest, which in turn causes resistance from both stakeholders and the client. As clients refuse to adopt IPD, there is a lack of industry-wide standardisation, leading to a high initial investment for new IPD projects. The significant investment causes resistance from the government in publicly funded projects, as they often seek the lowest cost. This leads to a lack of professional bodies being established in NZ, due to limited support for IPD, which in turn results in a lack of promotion and reduced awareness among contractors. This unfamiliarity causes challenging cultural

**Table 7.** Causal chain analysis.

Factors in the chain	Number of factors in the chain	Chain weight	Chain centrality weight (DC)	Chain centrality weight (EC)
The client needs to pay extra design fees-Contractual legal aspects-Self-protective approach-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of professional bodies-Lack of promotion-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms- <b>Lack of technology use</b> -BIM & IPD integration challenges	18	17	7.1739	2.576
The client needs to pay extra design fees-Contractual legal aspects-Self-protective approach-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of professional bodies-Lack of promotion-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms- <b>Lack of technology use</b> -Cost estimation challenges	18	17	7.1739	2.576
Industry participants lack chances to receive IPD training-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of professional bodies-Lack of promotion-Lack of existing training material- <b>Lack of technology use</b> -BIM & IPD integration challenges	17	16	6.5652	2.694
Industry participants lack chances to receive IPD training-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of professional bodies-Lack of promotion-Lack of existing training material- <b>Lack of technology use</b> -Cost estimation challenges	17	16	6.5652	2.694
Lack of professional bodies-Lack of promotion-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of existing training material- <b>Lack of technology use</b> -BIM & IPD integration challenges	16	15	6.4782	2.694
Lack of professional bodies-Lack of promotion-Lack of IPD awareness-Lack of familiarity of contractors-Challenging cultural paradigms-Lack of collaboration-Lack of integration-Lack of interest to upgrade- <b>Resistance to change-Client's resistance to change-Lack of industry standardisation-High initial investment</b> -Lack of governmental support-Lack of existing training material- <b>Lack of technology use</b> -Cost estimation challenges	16	15	6.4782	2.694

Source: Author's own work.

paradigms as the project parties resist IPD requirements, such as the use of modern technology. Ultimately, the lack of technology use creates challenges in cost estimation and difficulties with BIM and IPD integration. It is worth noting that, while chains 1 and 2, commencing with the client, have the most factors (18), they are not the strongest in terms of EC weightage. Chains 3 and 4, beginning with industry participants' lack of opportunities to receive IPD training, and chains 5 and 6, starting with a lack of professional bodies, are the heaviest, with eigenvalues of 2.694. This can form the basis of an argument that the lack of opportunities for industry participants to receive IPD training and the lack of professional

bodies associated with IPD are significant factors that impact IPD implementation in NZ.

Eight new NZ-specific factors were identified through the SSI, compared with those in other countries and regions (RQ3). These factors were not identified in the prior SLR conducted. The SSI did not reveal any interactions among these eight factors, which can serve as a basis for future research.

#### **Lack of factual information about outcomes from IPD in NZ**

The fact that resistance to change is one of the top factors influencing IPD in NZ is expected, given the lack of

documented case studies of successful IPD-delivered construction projects. Interviewee C10 quotes, “What have we got in terms of? Uh. Factual information about outcomes from IPD in New Zealand?” Additionally, the lack of professional bodies exacerbates the situation, as there is no governing body overseeing the implementation of IPD. Furthermore, the roles of lack of industry standardisation and mutual respect and trust are also evident. IPD has not received industry recognition in NZ due to a lack of factual information about outcomes, which has reduced industry trust. This contrasts with IPD implementation issues in other first-world countries. For example, in North America, there are documented cases of IPD since the delivery model was introduced in 2004 (Lichtag 2005). The limited number of contractors and consultants doesn’t help the IPD cause.

#### **Limited number of contractors and consultants**

Given NZ’s relatively small size, the limited number of construction professionals doesn’t help the IPD cause, especially when most of the workforce lacks IPD awareness. Interviewee C16 quotes, “And the fact that there are a limited number of both consultants and contractors and client organisations.” The impact of mutual respect and trust can be inferred from the limited number of consultants and contractors, suggesting that most of them may have prior working experience with one another. If the parties do not have the proper mutual respect and trust required, it will be difficult to enter into an IPD agreement. The limited number of consultants and contractors in NZ differs from other larger regions, such as North America. Due to NZ’s small population, there is no comparison between NZ’s construction sector and North America’s. Given that there are more Tier 1 international contractors in North America, the private sector is far more likely to implement the IPD model than in NZ. This implies that the room for IPD implementation is low in NZ. The fact that NZ has a complicated governance structure makes IPD implementation challenging.

#### **Federal versus local council model policy and governance conflicts**

One of the unique challenges in NZ compared to other countries is the complex governance structure relevant to the construction industry. There are three governing bodies- federal, regional, and local. The main issue is that each has its own rules, which can lead to immense confusion about legality and, in turn,

resistance. Resistance to change and clients’ resistance to change have been identified as critical factors to IPD in NZ, and it is not surprising to see why. Interviewee C4 quotes that, “the only thing real difference between New Zealand and other countries is the state *versus* local Council model or the state being the federal.” Further, interviewee C14 reconfirmed the use of a regional council code in NZ, as quoted, “Let’s go with something that’s New Zealand based. Like a Regional Council code and stuff. So when the alliance was formed, they would form to a certain spec and certain code. That’s how you get billed.” Through fragmented governance and regulation, the system is dis-integrated, particularly at the local government level, where multiple agencies, complex planning laws, and a lack of standardised processes hinder integrated, long-term planning and delivery. While it is true that governance in the construction sectors of most countries is fragmented, not all industry practitioners believe this is a factor in IPD implementation. For example, industry practitioners in Singapore do not consider the lack of government support a factor in IPD implementation (Ma *et al.* 2022). The NZ construction industry prefers traditional project delivery models over newer, untried ones.

#### **Industry opting for traditional models**

This can also be attributed to resistance to change. The construction sector in NZ is not interested in untried project delivery models. Interviewee C18 quotes, “So compared to, for example, other countries, New Zealand. Has a lot to improve. And more the views. Basically, most are still more traditional compared to for example other developed countries.” Additionally, industry participants lack opportunities to receive IPD training, which plays a role since the industry won’t become familiar with IPD in the absence of proper exposure. In comparison, the construction industry in larger regions such as North America is more familiar with other types of delivery models, including collaborative delivery models, and thus the traditional delivery model is not emphasised as it is in NZ. It was found out that resistance in NZ is mainly from the experienced professionals.

#### **Experienced professionals’ mindset**

One of the primary reasons for the prominence of resistance to change in NZ is that older, experienced professionals are often resistant to change. Younger professionals are more interested in modern

approaches but are not heard enough, as not much can be done if a director or chief executive is opposed to change. Interviewee C2 quotes, “My opinion, my personal opinion is, is that the younger generation are often more receptive to change processes, and the older generation are often seen believing that that’s always been done this way.” Industry participants’ lack of opportunities to receive IPD training also plays a significant role, as experienced members of the industry will continue to resist change unless properly educated about the advantages of collaborative delivery models, such as IPD. In larger regions, such as North America, there is likely to be less resistance from experienced professionals, as they are highly likely to have been part of an IPD-administered project and thus recognise its advantages. Also, there is a history of contractor liquidations in NZ.

### ***History of liquidation of contractors resisting risks***

Another prominent NZ-specific factor is that a large number of contractors have gone into liquidation, thereby increasing the caution they take. New project delivery approaches are deemed risky. Interviewee C6 quotes, “I think contractors have become more aware due to probably the number of main contractors that have gone into liquidations.” Additionally, the high initial investment is viewed as a precarious undertaking. It can be argued that contractor liquidations occur worldwide, but their impact in NZ is greater than in other regions. Given the already limited Tier 1 contractors in NZ, liquidations have a greater impact there than in other regions. Another relevant factor is that many subcontractors are taking on main contractor roles.

### ***Subcontractors taking main contractor roles***

The surge in contractors going into liquidation has led many subcontractors to take on main contractor roles. Smaller firms cannot meet IPD’s financial requirements and are thus resistant. This can be attributed to high initial investment and resistance to change. Interviewee C7 quotes, “Umm, I think the New Zealand context has a particular challenge in that contractors who were normally quite you know are moving from second tier to become what is our essentially our first tier or our subcontractors picking up more head contractor roles.” In comparison, this is not a significant concern in other large first-world countries where contractor liquidations are not on the rise. Lastly, project size is another NZ-specific factor.

### ***Project size***

Smaller projects are quite prevalent in NZ, and hence IPD is not seen as a feasible project delivery option. Interviewee C17 quotes, “Most of the projects we work on daily basis, they are very small in scale, which doesn’t require the IPD model.” This can again be resonated to resistance to change. This differs from countries such as China, where large-scale construction projects are prevalent, thereby increasing the likelihood of IPD implementation.

The research identified 139 interactions and eight new factors that affect IPD implementation in NZ. When understood, this will help policymakers, project managers, researchers, stakeholders, and academics build on it, paving the way for smoother implementation and reaping benefits.

### ***Conclusion***

In conclusion, the ultimate aim of IPD is continuous performance measurement. The value of IPD is realized by capturing data on quality, sustainability, cost, and time throughout the project lifecycle—from design and construction to facility management. This data is essential for objective evaluation and proving improvement. This study identifies the factors and their interactions that affect IPD implementation in NZ. It is essential to recognise that the factors of IPD do not operate in isolation; instead, they interact with other factors within the factor network, thereby amplifying their impact on its implementation. This research detailed the interactions between IPD factors through degree centrality, eigenvector centrality, and causal chain analyses. The results revealed that the NZ construction sector is still in a learning phase with respect to IPD and is far behind other developed nations in meeting the requirements for successful IPD implementation, such as technology use. Additionally, a significant number of policy changes and practical implications will need to be adhered to expect any chance of IPD implementation in NZ. Moreover, given the impact of the identified critical factors, it is reasonable to assume that IPD uptake should be a slow, steady process that will require cooperation from all stakeholders for successful implementation in NZ. The most plausible scenario for its uptake in the country is through public sector projects. As the NZ government is a major stakeholder in the construction sector, it can introduce the IPD framework to the wider sector by implementing it in its projects.

### Practical and theoretical implications

The practical implications of this study include guidance for industry practitioners on becoming familiar with the critical factors identified and how they interact to hinder IPD implementation in NZ. The lack of professional bodies has been identified as a significant factor indicating the need to establish a professional body for IPD. Additionally, another identified significant factor is that industry participants lack opportunities to receive IPD training; industry professionals should be given opportunities to receive IPD training. Moreover, resistance to change stems from several NZ-specific challenges. Without proper education on IPD benefits and the establishment of a professional body to oversee the training process, the situation in NZ is unlikely to improve. Additionally, overcoming conflicts between federal and local council governance and policy models requires cooperation from the government. It is recommended that IPD training begin in the government sector, as only then will a structured, smooth transition be possible for the NZ construction sector. As this is the first study on the interactions between factors and IPD implementation in NZ, the theoretical implications include further research to solidify these findings. Further research can also focus on developing strategies to resolve these issues and increase IPD implementation, ultimately boosting sustainable construction in NZ. The theoretical implications should also include guidance for practitioners on supporting their use of the solution-focused framework, with practical, logical, and feasible ideas.

### Future studies

Future studies can investigate the impact of the identified critical factors in more detail and quantify them, thereby solidifying these findings in the NZ context. Additionally, IPD factor interactions can be studied in other developed countries, and alternative data collection and analysis methods can be used.

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### Ethical approval

The Research Project was approved by the Auckland University of Technology Ethics Committee (AUTEC) on 26/10/23, AUTEC reference number 23/270. Ethics approval is available at: <https://tinyurl.com/3hsbbe4f>.

### Author contributions

CRediT: **Saad Bin Asad**: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft; **Mahesh Babu Purushothaman**: Conceptualization, Methodology, Project administration, Resources, Supervision, Writing – review & editing; **Mani Poshdar**: Methodology, Project administration, Supervision.

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### Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its Supplementary Materials. File share: <https://tinyurl.com/3hsbbe4f>.

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