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INTEGRATED PROJECT DELIVERY (IPD) IN ENTERPRISES SUBCONTRACTORS. CASE STUDY: ROAD IMPACT MITIGATION PROJECT

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ABSTRACT

This study analyzes the feasibility of applying Integrated Project Delivery (IPD) principles to construction subcontracts through a comparative analysis of a traditional lump-sum contract and a hypothetical IPD-based scenario. The bidding, award, execution, and closeout phases of a road impact mitigation project are examined to identify gaps and assess the impact of a collaborative approach on business profitability. The results suggest that implementing IPD could optimize the distribution of costs and benefits, allowing clients to maximize their savings and subcontractors to improve the predictability of their margins. However, challenges related to risk management and adaptation to new contractual dynamics are evident. Finally, the study highlights the potential of IPD to strengthen business relationships and foster sustainable long-term agreements.

KEYWORDS

IPD, Collaborative contract, Case Study, Subcontract, Comparative analysis.

INTRODUCTION

The construction industry plays a crucial role in the development of infrastructure and the dynamization of economies (Harvardaviation, 2024). However, it faces significant challenges related to the complexity and uncertainty inherent in large-scale projects, requiring integrated approaches to mitigate risks, enhance productivity, reduce error-related costs, and ensure quality at all stages of the construction process (Fisher et al., 2017; Refahy et al., 2024). This scenario is particularly critical in infrastructure projects, where tight deadlines and limited budgets place increased demands on the stakeholders involved (S. Buk'hail & Al-Sabah, 2024).

Traditional contracts, widely used in the construction industry, have shown limitations in managing the complexity of modern projects, leading to cost overruns, delays, and conflicts between parties due to a lack of collaboration and effective communication (Allison et al., 2018; Gomez et al., 2018; Granja et al., 2023). Furthermore, the fragmented structure of these contracts fosters an adversarial approach, making risk management and joint decision-making more difficult (Lukson et al., 2024).

In this context, the Integrated Project Delivery (IPD) method emerges as an innovative alternative to overcome the shortcomings of traditional contracts by promoting collaboration, risk sharing, and efficient project execution (Fisher et al., 2017; Medina, 2014). IPD fosters

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principles such as early collaboration, goal alignment, and transparency among all participants, which has proven effective in improving cost and schedule predictability, as well as fostering a more collaborative work environment (O'Dwyer et al., 2024; S. Buk'hail & Al-Sabah, 2024).

The purpose of this research is to present the results of a case study of a traditional road impact mitigation project and compare it with a hypothetical scenario based on a collaborative contract, identifying opportunities and gaps for its implementation. This study focuses on the perspective of a subcontractor, a key player in efficiency and cost reduction, but whose participation in decision-making processes is often restricted (Kim et al., 2007), It is worth noting that the administrative, contractual, budgetary, and operational information was obtained directly from the subcontractor, as one of the participants in this study is the owner of the subcontractor company. This ensured the reliability and accuracy of the analyzed information.

Furthermore, by comparing the results obtained under a traditional contract with the potential outcomes that could have been achieved through the implementation of IPD, this study draws upon documented best practices and principles outlined in the literature. It uses a framework for cost distribution, risk sharing, and stakeholder participation, aiming to identify inefficiencies and opportunities for improvement in traditional contracts (Fisher et al., 2017; AIA, 2007). This research provides insights into the feasibility of implementing collaborative contracts at the subcontractor level. However, it is important to note that the proposed IPD model does not represent an absolute ideal but serves as a reference for identifying inefficiencies and improvement opportunities within the existing contractual structure.

Given the above, the research question guiding this study is: Would the implementation of an IPD contract in a traditional tender for a specialized subcontractor provide benefits for the project stakeholders? Is there room for improvement that would be of interest to the subcontractor and allow them to use collaborative IPD-type contracts in projects in Chile?

The article is organized as follows: first, a theoretical framework on IPD is presented; next, the methodology and case analysis are described; then, the results and discussion are provided; and finally, the conclusions and recommendations are outlined.

BACKGROUND

INTEGRATED PROJECT DELIVERY

Integrated Project Delivery (IPD) is a construction management approach designed to optimize project outcomes through early and continuous collaboration between key stakeholders, such as owners, designers and contractors (Fisher et al., 2017). This system uses multi-party contracts that encourage goal alignment, risk and benefits sharing, and the use of advanced technologies such as Building Information Modelling (BIM) (Kahvandi et al., 2023).

IPD integrates people, systems, business structures and processes in a collaborative framework that seeks to maximize value for the owner, reduce waste and improve efficiency throughout all project phases, from design to construction (AIA, 2007; Refahy et al., 2024). This approach is based on mutual trust and open communication, fostering joint decision-making and collaborative innovation. The integration of stakeholders begins in the early stages of design and continues through final project delivery, ensuring a work environment focused on shared project goals (AIA, 2007; O'Dwyer et al., 2024).

PRINCIPLES OF IPD

According to various sources, the principles of the IPD can be classified into two main orders:

Contractual Principles

1. Collective benefit and incentive-based compensation: Stakeholders are rewarded based on their contribution to the project, which encourages behaviors aligned with the overall project objectives (AIA, 2007 ;Granja et al., 2023).

2. Shared financial risk and financial transparency: Financial management among the parties is clear and accessible, promoting trust among key stakeholders (Granja et al., 2023).
3. Early involvement of key stakeholders: Experts are integrated from the early design phase, maximizing their knowledge to positively influence project outcomes (AIA, 2007 ;O'Dwyer et al., 2024).

Behavioural Principles

1. Mutual respect and trust: All team members recognize the value of collaboration and work in the best interests of the project (AIA, 2007; O'Dwyer et al., 2024).
2. Early definition of goals: Project goals are established at the outset, ensuring a shared understanding among all stakeholders (AIA, 2007; Granja et al., 2023).
3. Open communication: This principle fosters a blame-free culture where problems are quickly identified and resolved (AIA, 2007).
4. Collaborative innovation and joint decision-making: Key decisions are made collectively, based on their merit rather than on the position or hierarchy of the proposer (AIA, 2007; Granja et al., 2023).
5. Technology integration: IPD relies on the use of advanced technologies, such as BIM platforms, to enhance interoperability and efficient communication among participants (O'Dwyer et al., 2024; AIA, 2007).

BENEFITS AND BARRIERS TO IPD IMPLEMENTATION

Benefits of IPD

Implementing IPD in construction enhances collaboration, transparency and efficiency. By integrating key stakeholders early in the design phase, IPD minimizes conflicts and improves project execution (Rached et al., 2014; Refahy et al., 2024).

General Benefits:

- Early Collaboration: Involves key stakeholders early in the design phase, reducing conflicts and allowing for better planning (Fisher et al., 2017)
- Transparency & Trust: Encourages open data sharing and minimizes adversarial relationships, fostering a more cooperative environment (Granja et al., 2023)
- Shared Risk and Rewards: Aligns incentives among all project participants, fostering accountability (Allison et al., 2018; AIA, 2007)
- Technology Integration: The use of BIM improves real time, decision-making and project visualization (Whang et al., 2019)

Project-Specific Outcomes:

- Cost Efficiency: Reduces material waste and minimizes change orders (Refahy et al., 2024)
- Schedule Optimization: Shortens lead times due to improved planning and coordination (Rached et al., 2014)
- Improved Safety: Lowers the risk of onsite accidents through better risk management strategies (Whang et al., 2019)
- Higher Quality Standards: Enhances construction efficiency and design accuracy, leading to fewer errors and improved project execution (Rached et al., 2014).

Barriers to IPD Implementation

Despite its advantages, the implementation of IPD faces several obstacles. Among the main barriers are cultural resistance to change, lack of familiarity with IPD principles, and distrust among stakeholders. Many companies prefer traditional methods due to organizational inertia and a lack of specific training in the IPD approach (Rached et al., 2014). Legal issues are also a major challenge, especially in the public sector, where laws favor selection criteria based on lower costs, making it difficult to use the multiparty agreements characteristic of IPD (Li & Ma, 2017). The lack of government support and the absence of specific programs or regulations also limit its implementation (Li & Ma, 2017). From a technical perspective, the implementation of tools such as BIM can be challenging, especially for subcontractors or smaller firms with limited experience in these technologies (Rached et al., 2014). Additionally, the lack of IPD experts and limited access to training programs affect its adoption (Li & Ma, 2017). In short-term projects, the time required to apply IPD is often insufficient, making adoption difficult. Furthermore, decision-making can be slow due to the large number of actors involved, leading to conflicts and a lack of collaborative skills (Refahy et al., 2024). Finally, the lack of standardized IPD contracts and the absence of adequate financial and structural incentives significantly affect its implementation (Whang et al., 2019).

METHODOLOGY

This research follows a structured case study methodology (Yin, 2018) to assess the feasibility of implementing Integrated Project Delivery (IPD). The methodology consists of three main stages: (1) selection of a case study relevant to subcontractor participation in IPD, (2) documentary analysis of financial, contractual, and operational data, and (3) comparison of results between a traditional contract and a proposed IPD-based model. Data was collected through direct collaboration with project stakeholders, ensuring access to real project documentation and financial records. Additionally, a literature review was conducted to provide a theoretical basis for evaluating the applicability of IPD in subcontractor environments.

CASE STUDY SELECTION

The chosen case study analyzes a road impact mitigation project in Concepción, Chile. This project was executed by a subcontractor with the objective of improving the road infrastructure and reducing traffic congestion caused by the impact of a real estate project. Also, the project was selected for its relevance in the comparative analysis between traditional contracts and the Integrated Project Delivery (IPD) model (Fisher et al., 2017), due to its practical implications for subcontractors in collaborative schemes. Although subcontractors typically have limited contractual influence, previous research indicates that they can contribute significantly to process improvement through the adoption of Lean Construction principles (Kim et al., 2007). Since IPD promotes collaboration, cost sharing and early participation, the case allows evaluating its applicability in traditional frameworks (Granja et al., 2023). Moreover, considering that in Chile the regulations require having the designs prior to bidding, which restricts the full implementation of IPD (Corporación de Desarrollo Tecnológico, 2019), this case is relevant to explore possible adaptations of the model. The study seeks to contribute to the discussion on how subcontractors can facilitate the adoption of IPD in restrictive contractual environments (AIA, 2007).

According to Yin (2018), the selection of the case study is crucial, as it ensures that the findings are relevant and contribute meaningfully to the research objectives. In this study, the administrative, contractual, budgetary, and operational information of the project was provided by the subcontractor, since one of the participants is the owner of the subcontracting company.

DOCUMENT ANALYSIS

A detailed analysis of the project documentation was conducted during the bidding process, including the traditional contract, technical and financial reports, as well as the eight submitted budgets, identifying cost overruns and savings in the final proposal. According to Kim et al. (2007) and Flick (2018), document analysis is key to evaluating the influence of subcontractors on the continuous improvement of processes.

To ensure a solid theoretical foundation, a literature review was conducted using peer-reviewed sources from databases such as Scopus, Taylor & Francis, and Emerald Insight. The keyword combination used included:

- "Integrated Project Delivery + Implementation"
- "IPD + Barriers and Benefits"
- "IPD + Construction Management"
- "IPD + Collaborative Contracts"

The combination of document analysis and theoretical review enabled an evaluation of how an IPD approach could be adapted to the project's context, providing empirical evidence on its feasibility in subcontractor-led projects.

COMPARISON OF RESULTS

The project's lump sum contract, established between the subcontractor and the general contractor, along with the guidelines outlined in the IPD Guide by AIA (2007), served as the basis for developing an IPD-based contract proposal adapted to the Chilean regulatory framework. It is important to note that in Chile, certain legal constraints hinder the full implementation of IPD (Corporación de Desarrollo Tecnológico, 2019). For instance, national regulations require a company to hire a designer to develop the project design before initiating the bidding process. This limitation was carefully considered when structuring the proposed model.

A thorough analysis was conducted on the budget initially established in the lump sum contract between the subcontractor and the general contractor (referred to as the original budget) and the actual costs incurred during project execution (final budget). The discrepancies between these budgets were analyzed to identify cost variations and inefficiencies in the traditional contract model. Based on the proposed IPD contract model, a revised budget was estimated, incorporating equitable cost distribution and profit-sharing principles derived from the literature.

In this context, cost analysis becomes crucial. According to Kim & Ballard (2002), construction projects often face challenges due to the improper allocation of indirect costs, which can distort profitability and complicate financial analysis. The study advocates for adopting an activity-based costing approach to improve cost understanding and subcontractor relations. It compares the results of two contractual approaches, highlighting that implementing the IPD model could lead to a fairer distribution of costs and profits, improving satisfaction and project efficiency (Figure 1). A hypothetical IPD scenario was developed based on standard IPD principles, with the proposed framework, cost distribution, and risk-sharing mechanisms derived from literature on IPD and Lean Construction, including:

- Standard IPD contracts structures (AIA, 2007)
- Risk and profit-sharing in collaborative contracts (Fisher et al., 2017)
- Best practices in IPD implementation (Allison et al., 2018)
- Context on collaborative contracts in Chile (Corporación de Desarrollo Tecnológico, 2019)

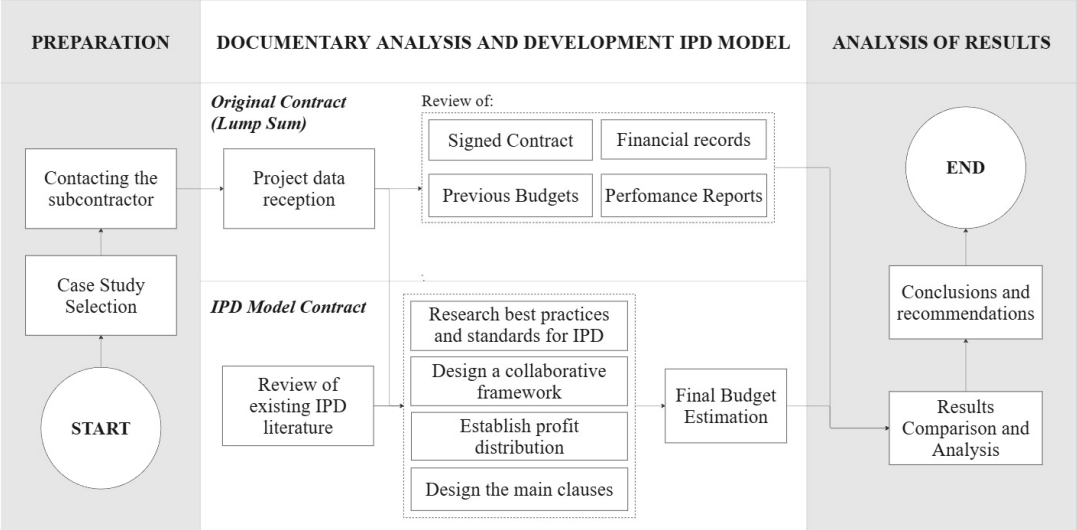

Figure 1. Methodology flow diagram

RESULTS AND DISCUSSION

CASE STUDY

Project Description

The study focuses on a road impact mitigation project in the municipality of San Pedro de la Paz, Biobío region, Chile. Its purpose is to ensure safe mobility for all road users. This project, developed under the Chilean legal framework in the traditional contract modality, has a budget of 35,881,909.00 CLP. Planned interventions include the implementation of road safety features such as signage, demarcation, warning devices and speed reducers.

Table 1 compares the planned cost under a lump sum contract with the actual cost, based on subcontractor financial records. The differences are due to factors such as scope changes, supplier selection, and indirect cost variations, highlighting the challenges of cost predictability in traditional contracts and the need for alternative frameworks like IPD.

Table 1. Planned vs. Actual Budget (CLP) and Reasons for variations.

Work Item	Budgeted Cost	Actual Cost	Why the gap?
Signage	5,306,577.00	2,706,941.00	Scope review
Floor demarcation	15,924,105.00	9,893,812.00	Scope review
Pedestrian Fences	5,567,895.00	4,118,000.00	Vendor selection
Internal parking lots	2,522,100.00	2,309,966.00	Scope review
Other materials	633,684.00	596,495.00	Scope review
Permits	1,157,896.00	648,212.00	Saving in execution
Additional	-	107,001.00	Unforeseen scope
General expenses	3,422,438.00	2,210,621.00	Lower direct cost
Profit	1,347,304.00	13,290,861.00	Operating difference

Figure 2 shows the evolution of eight budget revisions during the bidding stage, based on changes in scope, cost, duration, and project considerations. The scope was modified until revision 8, while the duration and considerations stabilized after revision 5. Direct costs

fluctuated across the different versions, reflecting the iterative nature of subcontractor bidding processes. Unlike a fixed budget, these revisions represent progressive improvements before reaching a final agreement, and documenting this process is crucial to identify opportunities for improvement and optimize future bidding strategies.

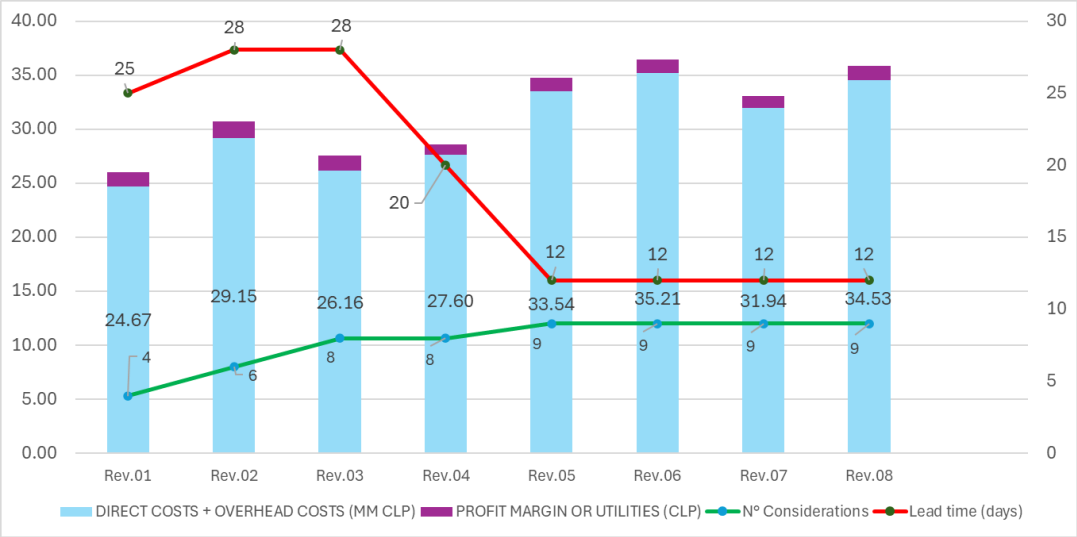

Figure 2. Evolution of the 8 budgets made by the SC during the bidding phase.

Figure 3 compares cost distribution across three scenarios: the original contract, the actual project cost, and a hypothetical IPD-based model. The first column represents the initial contract value, including direct costs, overhead, and expected profits. The second column shows the actual project costs, where scope changes reduced direct costs but increased the subcontractor's profit margin. The third column illustrates the hypothetical IPD scenario, where efficiency gains are shared equally between the subcontractor and the client (Fisher et al., 2017, p. 471). This comparison emphasizes how an open-book IPD approach can promote transparency and a fairer allocation of savings, reducing overall project costs.

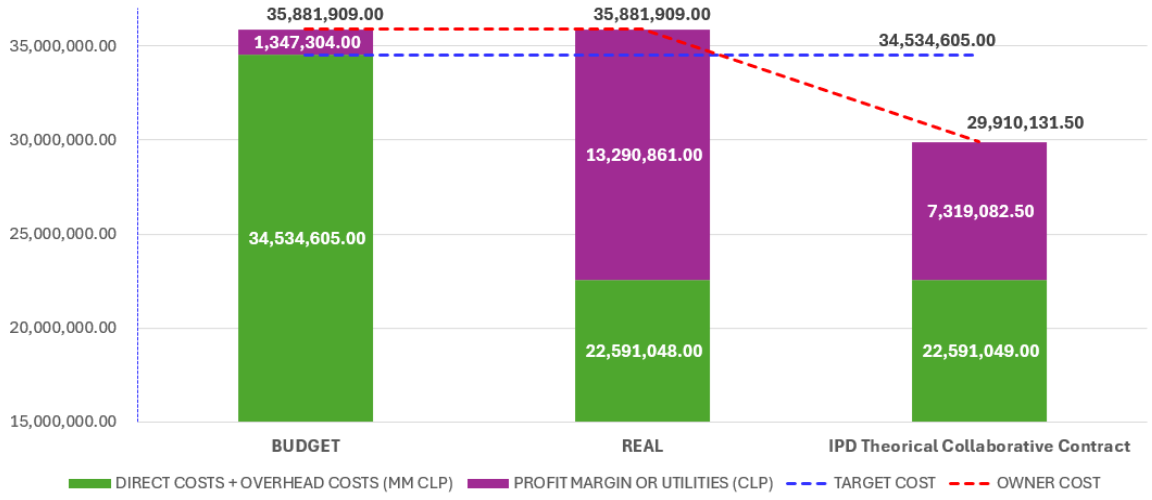

Figure 3. Budgeted vs. Actual Cost and Cost Distribution under an IPD Model.

PROJECT CONTRACT

Table 2 presents the main clauses of the lump sum contract between the subcontractor and the general contractor, covering aspects like modifications, deadlines, price, penalties, communications, arbitration, and subcontracting. A proposal for implementing collaborative contracts, sourced primarily from the Technological Development Corporation (CDT) of the

Chilean Chamber of Construction, is introduced. This proposal is adapted to assess the feasibility of implementing the Integrated Project Delivery (IPD) model, which supports early stakeholder involvement, equitable risk and benefit distribution, and process optimization, making it an ideal solution for IPD implementation (Fisher et al., 2017; AIA, 2007).

Table 2. Main clauses of the lump sum contract

Clauses	Description
Modifications	The Construction Company may modify the work without altering its nature. Additional work requires a written order approved by both parties, with defined price and time frame.
Deadline	The execution period is from June 10 to July 31, 2024. In case of delays, notice is required to be given within 48 hours. The Company may terminate the contract for failure to meet deadlines.
Price	The Contractor undertakes to execute the work entrusted to it on a lump sum basis. The general contractor does not guarantee that this contract will generate profits for the subcontractor.
Fines	Fines for non-compliance with quality, risk prevention, environmental and work deadlines.
Communications	All communication must be in writing, by means of the Book of Works or letter, and signed by the authorized representatives. Other formal means are not accepted.
Arbitration	Any dispute related to the contract shall be settled by arbitration at the Arbitration Center of the Santiago Chamber of Commerce.

IMPACT OF IPD ON SUBCONTRATORS

IPD modifies subcontractor involvement by promoting early participation, cost transparency, and risk-sharing (Fisher et al., 2017). Unlike lump sum contracts, where subcontractors have limited influence in design and budgeting, IPD allows them to contribute expertise from the outset, reducing cost overruns and rework (Granja et al., 2023).

Financially, IPD replaces the fixed-price model with an open-book approach, where savings and risks are shared equitably (Corporación de Desarrollo Tecnológico, 2019) .This enhances profitability predictability but requires subcontractors to adapt their financial strategies.

A major challenge is the need for digital integration, as IPD relies on BIM and collaborative planning tools (Whang et al., 2019). Smaller subcontractors may require training to align with these workflows. Despite these challenges, IPD enhances subcontractor accountability and operational efficiency by aligning incentives with project success (Fisher et al., 2017).

IMPLEMENTATION OF IPD CONTRACT

According to the guidelines of the Collaborative Contracts Protocol of the Technological Development Corporation (CDT) of the Chilean Chamber of Construction (Corporación de Desarrollo Tecnológico, 2019), which was adapted in a theoretical way to see the possibility of implementing the Integrated Project Delivery (IPD) model, the clauses of the lump sum contract, shown in Table 2, were analyzed. As a result, an implementation proposal was developed based on the theoretical principles of IPD to the main clauses of the lump sum contract, as shown in Table 3.

Table 3. IPD Contract Proposal

Clauses	Description
Modifications	Modifications are managed collaboratively, with the recommendation to involve the designer during the bidding stage alongside the recipient entity to optimize the project and select a subcontractor under a collaborative contract, ensuring their participation in design definition and improvement.
Deadline	The schedule is flexible and managed collaboratively between the general contractor and subcontractor, with constant communication to adjust the contract as needed. Emphasis is placed on anticipating risks and identifying opportunities to optimize project execution.
Price	This section defines the target price and savings margin, with half of the profit allocated to each party and corresponding incentives. Additionally, savings generated in the design are equally distributed between the client and the contractor.
Fines	The application of a fine should only be considered if the subcontractor acts in bad faith.
Communications	Clear and frequent communication should be ensured through regular ICE meetings, involving all key members of the IPD team.
Arbitration	Mediation and early conflict resolution are promoted through an internal commission.

COMPARATIVE ANALYSIS

By developing the proposal shown in Table 3, gaps and opportunities are identified in the implementation of the theoretical principles of IPD in the case study.

Table 4. Gaps and opportunities in the implementation of theoretical IPD principles in a subcontractor's lump sum case study contract.

Clauses	Gaps	Opportunities
Modifications	There is little flexibility to adapt to changes.[1]	Greater integration of project stakeholders in decisions about modifications or changes.
Deadline	Traditionally, deadlines are rigid, with little flexibility to adjust times. [1]	Greater flexibility in scheduling and risk anticipation.
Price	Collaboration to generate savings is not encouraged. [2]	Implementation of incentives to optimize the project and share benefits.
Fines	A collaborative approach is generally not promoted, but rather a punitive one. [3]	Promote early and internal conflict resolution.
Communications	Communication and decisions often follow a hierarchical structure, with less interaction between parties.[1]	Improved communication between project parties.
Arbitration	Arbitration is the preferred method of dispute resolution and is typically governed by Chilean law and conducted in Santiago. [4]	Promoting mediation and early conflict resolution.

[1](Tecnológico, 2019). [2](Ortega et al., 2023). [3](Araya Ibáñez, 2018). [4](Serpell & Ferrada, 2020).

DISCUSSION

It is possible to observe that the bidding stage has many iterations. In the case study, these were eight times, and only in the fifth iteration does it stabilize in relation to the time frame and the number of inquiries made. It is then, according to our observation criteria, that the proposal should be made to award the contract to the subcontractor through a collaborative contract. Likewise, keeping indicators of the bid quote numbers, the number of inquiries made, the information requests (bid RFIs), or the considerations taken are necessary to help make decisions about which contractor to choose. More than the proposed price, the technical input provided in this bidding stage will allow for a clearer understanding of the scope of the project and should be a highly weighted criterion for selecting the contractor with whom they will retain and to whom they will propose the collaborative contract.

From a contract acceptance perspective, it is important to have the municipal authority that will receive the work involved, as it is possible to reach optimizations with that person when the scope of the project has many uncertainties, and a prior visit by said agent can result in significant savings. In this case study, the subcontractor arranged this meeting after the contract was awarded, achieving significant savings that impacted the outcome.

While in this case study the subcontractor was able to obtain benefits far above its initial proposal, the opposite could also have happened if the risks were not adequately managed. This indicates that a proactive attitude toward anticipating these risks is key and can make the difference between a positive and an adverse outcome. In this sense, the internal involvement of the final recipient, the general contractor, and the subcontractor is key. Evidence showed that there is a significant opportunity gap for the parties if they decide to collaborate and an opportunity to distribute the potential savings among those involved, strengthening long-term relationships.

CONCLUSIONS AND RECOMENDATIONS

It is possible to see that despite the advantages of using IPD collaborative contracts, these are not yet a standard in the industry for the reasons mentioned in the literature search. Here it is possible to show that, assuming that they are used appropriately from the corresponding stages, the benefits would be for the client, the general contractor and the subcontractor.

The profit margins of well-coordinated and executed projects can be in the order of 40% to 50%, which is an attractive contract for the proponents. Therefore, it is important to indicate that limiting the profit risks, a margin of 20% to 25% is still attractive to any subcontractor, given that their risk could be more limited and the loss, if they exist, more limited, so a collaborative contract could be chosen.

An analysis of the current contracts in the case study shows that a large number of items, also known as "cost centers," show positive differences, mainly due to scope reviews. In this case, these changes could be reduced, as the scope was reduced due to the involvement of the end user at an opportune stage prior to project execution, generating benefits in scope definition. This could also be the opposite, to the detriment of the project; therefore, reviews and support from the specialized subcontractor are essential to take advantage of these savings opportunities and should be considered to promote the use of IPD contracts between the parties.

Finally, it is recommended to explore other subcontracting company projects using the proposed research methodology to validate or corroborate the assumptions and develop a collaborative model proposal focused on subcontracting companies.

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